



**ASSOCIATION OF ALL
COMPUTER SCIENCE TEACHERS (AACST)**
कॉम्प्यूटर विज्ञान शिक्षक संघ [Reg. No: Nagpur/0000492/2023]
September 2023

**REPORT
ON
NATIONAL LEVEL ONLINE WORKSHOP
QUANTUM COMPUTING TECHNOLOGIES: EXPLORING INTERDISCIPLINARY
FRONTIERS**

5TH TO 16TH AUGUST 2024

**ORGANIZED BY
AACST BANGALORE UNIT**

**MENTOR:
DR. ABHA KHANDELWAL
FOUNDER, AACST**

**WORKSHOP CONVENER:
DR. CHITRA RAVI
AACST BANGALORE UNIT EVENT COORDINATOR**



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September 2023



Join us for an exhilarating journey into the world of Quantum Computing! This cutting-edge workshop, "Quantum Computing Technologies: Exploring Interdisciplinary Frontiers", is designed to bridge the gap between theory and practice, and to open up new horizons in technology and science. This workshop offers a unique opportunity to dive deep into the transformative potential of quantum computing.

Experience hands-on sessions led by renowned experts, delve into pioneering quantum algorithms, and discover groundbreaking applications across various fields.

Don't miss out on the chance to be at the forefront of this revolutionary technology.

Secure your spot now and be part of the quantum revolution!



5th to 16th August 2024



6:30 to 8:00 PM



Zoom Meeting



Rs. 1000/- per participant

Scan to
register



Scan to
Pay



<https://forms.gle/Y56tDZu6C4avxvLk6>

Course Highlights:

- Sessions led by expert faculty members
- Exploration of cutting-edge technology
- Hands-on experience with Quantum computing tools
- Course completion certificate

Course Outcomes:

- Understand Quantum computing fundamentals
- Develop and Implement Quantum Algorithms
- Apply Quantum Computing to interdisciplinary Problems

Target Audience:

- Students/Faculty members/Research scholars/ Educators/ Professionals

**MENTOR****Dr. Abha Khandelwal, Founder, AACST****WORKSHOP
CONVENER****Dr. Chitra Ravi, Research Director,
Cybersena (R&D) India Pvt. Ltd., Bangalore****RESOURCE PERSONS**

1. Dr. Abha Khandelwal, Founder, AACST, Nagpur
2. Dr. Chitra Ravi, Research Director, Cybersena (R&D) India Pvt. Ltd. Bangalore
3. Dr. Vandna Luthra, Gargi College, New Delhi
4. Dr. Rohini V, Christ University, Bangalore
5. Dr. Jyoti M Ghush, PICT Model School, Pune
6. Dr. Vijayalakshmi A Lepakshi, Reva University, Bangalore
7. Dr. Manjula Sanjay, Dayananda Sagar Academy of Technology and Management, Bangalore
8. Dr. Melita Luke, CMR University, Bangalore
9. Dr. Kumar Chander, Christ University, Bangalore
10. Dr. Umadevi R, CMR University, Bangalore
11. Dr. Chitra K, Dayananda Sagar Academy of Technology and Management, Bangalore

For any queries
write to

qcworkshop0724@gmail.com





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कॉम्प्यूटर विज्ञान शिक्षक संघ [Reg. No: Nagpur/0000492/2023] September 2023

ONLINE WORKSHOP ON

“QUANTUM COMPUTING TECHNOLOGIES: EXPLORING INTERDISCIPLINARY FRONTIERS”

Workshop Highlights:

- Exploration of Quantum computing fundamentals, Algorithms, Thought experiments, Applications- Cybersecurity, Machine Learning, Data analytics, Drug Discovery & Health Care, Sensors and Imaging, Financial Modelling, Environment and Sustainability
- Application of concepts to Interdisciplinary problems through Quantum computing tool – IBM Quiskit
- Course completion Certificate

Mentor: Dr. Abha Khandelwal, Founder, AACST, Nagpur

Convener: Dr. Chitra Ravi, AACST Bangalore Unit Event Coordinator, Bangalore

Target Audience:

Students/Faculty members/Research scholars/ Professionals

Limited seats !

Register now to secure your seat.

Scan to Pay

Scan to Register



5th to 16th August 2024

6:30 to 8:00 PM

Zoom Meeting



***Rs. 1000/- for Non-AACST members**

***Rs. 800/- for AACST members**

***Rs. 800/- for IAPT members**

Registration Link:

<https://forms.gle/7Atc1bXcKBGKfo5Y6>

Event Overview:

The National Level Online Workshop on cutting edge technology, “Quantum Computing Technologies: Exploring Interdisciplinary Frontiers” was organized by AACST Bangalore Unit successfully from 5th August to 16th August 2024, 6:30 to 8:00 PM. The workshop attracted 78 participants, including ex-vice-chancellors, professors, teachers, research scholars, and PG students.

This cutting-edge workshop was designed to bridge the gap between theory and practice, and to open up new horizons in quantum technologies beginning from quantum key concepts, quantum gates and circuits, quantum algorithms and their applications in various domains such as healthcare, cybersecurity, Data analytics and Big data, Environment and Sustainability, Quantum Finance, etc. This workshop offered a unique opportunity to dive deep into the transformative potential of quantum computing.

Number of participants: 78

Target Audience: Students/Professors/Heads of Departments/Principal/Ex Pro VC/IT professionals

Mentor: Dr. Abha Khandelwal, Retired Head, Dept of Computer Science, Hislop College, Nagpur & Founder, AACST

Workshop Convener: Dr. Chitra Ravi, Research Director, Cybersena (R&D) India Pvt. Ltd., Bangalore & AACST Bangalore Unit Event Coordinator

Resource persons:

1. Dr. Chitra Ravi, Director, Cybersena (R&D) India Pvt. Ltd., Bangalore
2. Dr. Vandana Luthra, Associate Professor, Gargi College, New Delhi
3. Dr. Jyothi Manish Ghushie, PICT Model School, Pune

4. Dr. Rohini V, Professor, School of Computer Applications, Christ University, Bangalore
5. Dr. Abha Khandelwal, Retired Head, Dept of Computer Science, Hislop College, Nagpur & Founder Director, AACST
6. Dr. Melita Luke, Associate Professor, Yenapoya University, Bangalore
7. Dr. Vijayalakshmi A Lepakshi, Associate Professor, School of Computer Science and Applications, Reva University, Bangalore
8. Dr. Manjula Sanjay, Professor & HOD, Dayandand Sagar Academy of Technology and Management
9. Dr. Umadevi Ramamoorthy, Associate Professor, CMR University, Bangalore
10. Dr. Chitra K, Associate Professor, Dayanand Sagar Academy of Technology and Management
11. Dr. Kumar Chandar, Associate Professor, School of Business and Management Studies, Christ University, Bangalore

Session Chairpersons:

1. Dr. Arvind Kulkarni, Science and Technology Communicator & Learning Developer, Bangalore
2. Dr. S. B. Kishor, Head Department of Computer Science & Head of IHLRSS (Institute of Higher Learning Research), , Sardar Patel Mahavidyalaya, Ganj Ward, Chandrapur, Maharashtra & President, AACST, Nagpur
3. Sarmistha Sahu, Retd. Prof of Physics, Coordinator, Ammanni IAPT Anveshika (Wing of NANI, Indian Association of Physics Teachers), Bangalore 560097
4. Dr. Dillip Kumar Bisoyi, Professor of Physics and Astronomy, NIT, Rourkela, Odisha
5. Dr. Ashish B Sasankar, Principal, Indraprastha New Arts, Commerce and Science college, Wardha
6. Dr. Ramesh R Manza, Professor, Biomedical Image Processing Laboratory, Department of Computer Science and Information Technology, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad
7. Prof Manu Pratap Singh, Professor & Director, Department of Computer Science, Khandari Campus, Dr. Bhimrao Ambedkar University, Agra.
8. Prof Sumeet Gill, Professor, Department of Mathematics, Maharshi Dayanand University, Rohtak, Haryana
9. Prof P K Ahluwalia, Professor of Physics (Retd.), Himachal Pradesh University & IAPT President, Shimla
10. Dr. Jigisha Naidu, Director, Department of Commerce, Management and Computer Science, Hislop College, Nagpur
11. Prof Jayant Deshpande, Retd. Pro Vice Chancellor, Amravati University, Amravati, Maharashtra

Master of Ceremony:

1. Ms. Shruthi C Karigar
2. Dr. Chitra K
3. Dr. Melita Luke

Course Contents:**Session 1: Overview of Quantum Computing**

1. Introduction to Quantum Computing
 - What is Quantum Computing?
 - Bits to Qubits
 - Features of Quantum computing
 - Key players of Quantum computing
2. Importance of Quantum computing
3. Evolution of Quantum Computing
4. Quantum Concepts
5. Components of Quantum computer
6. Types of Quantum Computers
7. Conclusion

Session 2: Quantum Gates and Circuits

1. Introduction to Qubits
2. Quantum Gates
3. Quantum Circuits
4. IBM Quantum Composer
5. Demo of Quantum gates on Simulator
6. Introduction to IBM Qiskit tool
7. Demonstration of writing code and execution
8. Bell states and Bell state measurement

Session 3: Quantum Thought Experiments

1. Introduction to Quantum Thought Experiments
2. Schrodinger's cat Decoherence
3. Wigner's friend – Superposition and Entanglement measurement
4. Double slit experiment – Wave Particle Duality
5. Mach-Zehnder Interferometer
6. Conclusion

Session 4: Exploring Quantum Algorithms

1. Introduction to Quantum Algorithms
2. Importance of Quantum Algorithms
3. Deutsch-Jozsa Algorithm – Implementation using IBM Qiskit on Google colab
4. Quantum Fourier Transform (QFT)
5. Shor's Algorithm
6. Grover's Algorithm
7. Quantum Phase Estimation (QPE)

8. Conclusion

Session 5: Cybersecurity in Quantum Age

1. Introduction to Cybersecurity
2. Evolution of Quantum cryptography
3. BB84 protocol
4. One time pad
5. Quantum Key Distribution
6. Post Quantum Cryptography – Lattice based, code based, hash based, Multi variate polynomial cryptography

Session 6: Quantum Computing for Drug Discovery and Healthcare

1. Introduction
2. Applications of Quantum Computing in Healthcare with Real world examples
3. Quantum Machine Learning in Healthcare
4. Quantum Algorithms for Drug Discovery
5. Challenges and Limitations
6. Prospects and Trends
7. Conclusion

Session 7: Quantum Machine Learning

1. Introduction
2. Basics of Machine Learning
 - Classical Machine Learning Overview
 - Challenges in Classical Machine Learning
3. Introduction to Quantum Machine Learning
4. Quantum Machine Learning Fundamentals
 - Quantum Data and Features
 - Quantum Algorithms for Machine learning
5. Key Quantum Machine Learning Models
 - Quantum Principal Component Analysis (QPCA)
 - Quantum Neural Networks (QNN)
 - Quantum K-Means and Clustering Algorithms
 - Quantum Support Vector Machines (QSVM)
6. Implementation of quantum-enhanced algorithm using QSVM using Qiskit tool
7. Applications of Quantum Machine Learning
8. Future of Quantum Machine Learning
9. Conclusion

Session 8: Quantum Computing in Data Analytics and Big Data

1. Importance of Data Analytics
2. Challenges of Classical Data Analysis

3. Quantum Data Processing
4. Quantum Computing for Data Analytics
5. Applications of Quantum computing in Data Analytics
6. Challenges and Limitations of Quantum computing in Big data and Data analytics
7. Quantum Optimization Algorithms
8. Future Directions and Conclusion

Session 9: Quantum computing in Sensors and Imaging

1. Introduction to Quantum Technologies
2. Quantum Sensors
3. Quantum Imaging
4. Quantum Sensor Simulation Example
5. Program using Qiskit
6. Conclusion

Session 10: Quantum Computing: Driving Innovation in Environment and Sustainability

1. Introduction
2. Applications of Quantum Computing in Environment and Sustainability
3. Pollution Reduction
4. Waste Management and Recycling
5. Green Chemistry and Eco friendly materials
6. Carbon Capture and Reduction
7. Resource Allocation
8. Renewable Energy Optimization
9. Sustainable Agriculture and Water Management
10. Biodiversity Conservation
11. Climate Modeling and Weather Forecasting
12. Climate Modeling and Prediction
13. Hands on Session on Climate Modeling using Qiskit tool
14. Conclusion

Session 11: Quantum Finance

1. Traditional Finance vs Quantum Finance
2. Transition and Evolution of Finance Technology (FinTech)
3. Quantum Computing in Banking and Finance
4. Quantum Computing and Stock Trading
5. Quantum Machine Learning algorithms in Finance
6. Benefits of Quantum Finance
7. Challenges in Quantum Finance
8. Future Directions
9. Conclusion

Course Highlights:

1. Sessions led by expert faculty members
2. Exploration of cutting edge technology
3. Hands on experience with Quantum computing simulators (IBM Quantum Composer) and SDK tool (IBM Qiskit) with Google Colab
4. Course completion certificate
5. All session Video Recordings posted in Google Class Room.
6. At the end of each session, Assessment was conducted in the form of Quiz.

Course Outcomes:

1. Understand foundational key Quantum computing concepts
2. Develop skill of using Quantum simulators for using quantum gates and designing quantum circuits
3. Ability to develop and implement quantum algorithms using Quantum computing tool-Qiskit
4. Ability to apply quantum computing concepts and algorithms to solve interdisciplinary problems
5. Awareness of various research areas of quantum computing and current status.

Recorded Lectures: Were made available on Google Classroom for revision before assessment.

Assessment and Certification

Participants were assessed through topic-wise assignments and required to maintain 75% attendance and submission of assignments. Participation certificates were awarded to those meeting the criteria.

Valedictory Function

The valedictory function was organized on 16th August 2024. It was attended by all participants, resource persons and session chairpersons. The Chief Guest was Dr. S. B Kishor, Head Department of Computer Science & Head of IHLRSS (Institute of Higher Learning Research), Sardar Patel Mahavidyalaya, Ganj Ward, Chandrapur, Maharashtra & President, AACST, Nagpur.

Dr. Chitra Ravi, Research Director, Cybersena (R&D) India Pvt. Ltd, Bangalore, AACST Bangalore Unit Event Coordinator and Workshop Convener, presented a report on the 11 day National level online Workshop proceedings.

About 5 participants gave their oral feedback about the various sessions of the workshop, shared their thoughts and reflections in the form of learnings, networking, experiences and key takeaways requesting for conducting more such workshops in niche areas.

Dr. Abha Khandelwal gave her closing remarks and attributed the success of the workshop to all the resource persons and participants who were very enthusiastic and interactive. She appreciated all those who were involved in the workshop and asked us to carry this knowledge forward and delve deeper into quantum computing and to contribute to innovation.

Dr. Chitra Ravi, Workshop convener proposed the vote of thanks. She thanked the Chief Guest of the Valedictory function, Chairpersons of all sessions, Resource persons of all sessions, Mentor of workshop for her continuous support and being the driving force, Master of Ceremony for their seamless coordination and engaging presence, Designer of Workshop flyer and certificate.

Summary of the Report:

The title “Quantum Computing Technologies: Exploring Interdisciplinary Frontiers” was coined by Workshop mentor and founder AACST, Dr. Abha Khandelwal. An enthusiastic team of life members of AACST, who are working in the quantum computing field (both physics and computer science specializations) were identified to be the resource persons, from New Delhi, Pune, Nagpur and Bangalore.

The immersive workshop was a dynamic and thought-provoking event that brought together a diverse group of 78 brilliant students, researchers, faculty members, professionals and enthusiastic learners from various fields from across states of India, in order to explore the cutting edge technology that is the future of computing.

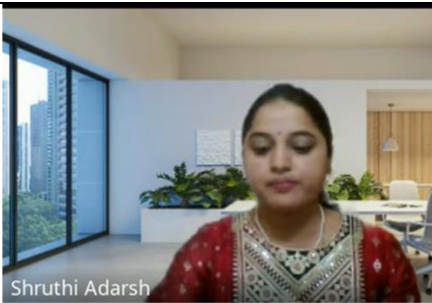
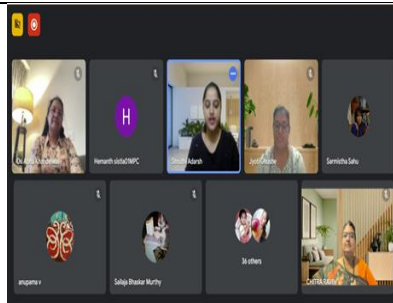
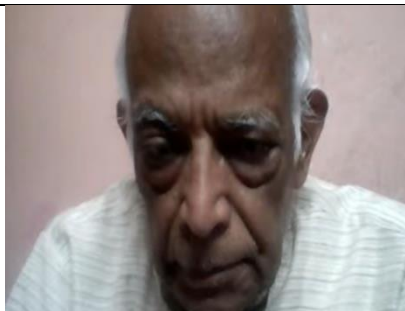
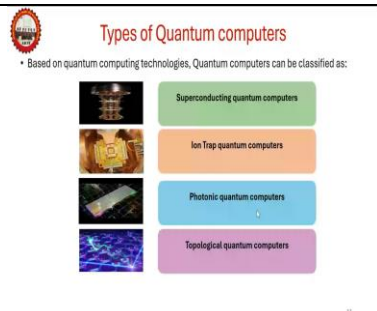
The workshop spanned 11 days and included a series of technical sessions, and interactive discussions. Over the course of several engaging days, participants were exposed to cutting-edge theories and innovative practices in quantum computing, with a particular emphasis on its far-reaching interdisciplinary applications. Participants explored the theoretical foundations of quantum computing, its practical applications, and the challenges faced in integrating quantum technologies across different disciplines.

The sessions were delivered by expert faculty members who not only explained quantum computing key concepts, but also demonstrated the use of Quantum simulator and Qiskit SDK tool for implementation of quantum gates, circuits and algorithms.

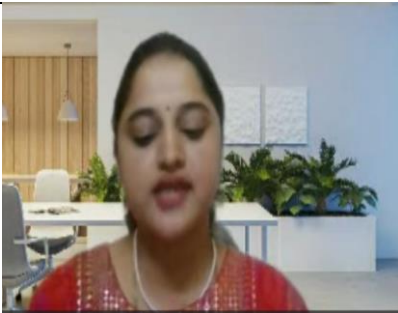
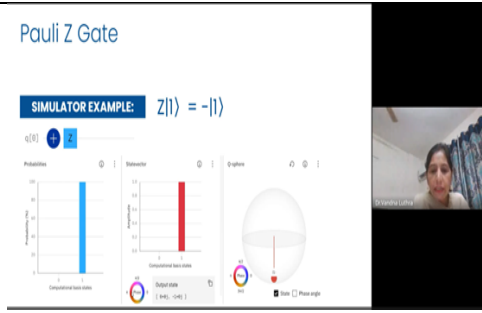
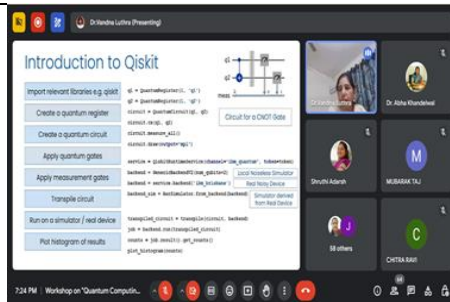
Key highlights of the workshop included:

- Basic sessions on quantum computing concepts
- Exploration of implementing quantum gates and circuits using simulators
- Understanding key quantum concepts through Thought experiments
- Exploration of Quantum algorithms and implementation through Qiskit tool
- Quantum Machine Learning and implementation of algorithms through Qiskit tool
- Discussions on the interdisciplinary applications of quantum computing in fields such as Cybersecurity, Drug Discovery and Healthcare, Data Analytics and Big Data, Sensors and Imaging, artificial intelligence, material science, and cybersecurity.
- Hands-on sessions and demonstrations of quantum computing platforms.

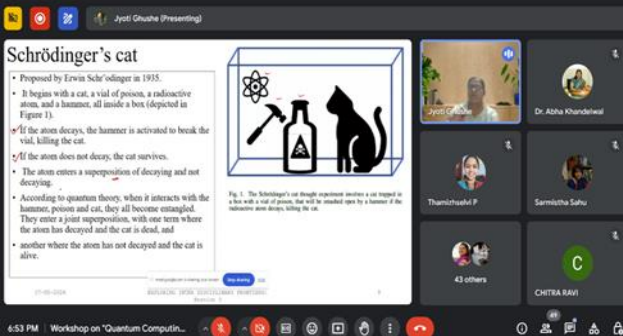
Gallery:**Day 1: 5th August 2024 6:30 to 8:00 PM**

		
Master of Ceremony Shruthi C K	Workshop Mentor Dr. Abha Khandelwal	Participants
		
Resource person Dr. Chitra Ravi	Chair person Dr. Arvind Kulkarni	Session snapshot

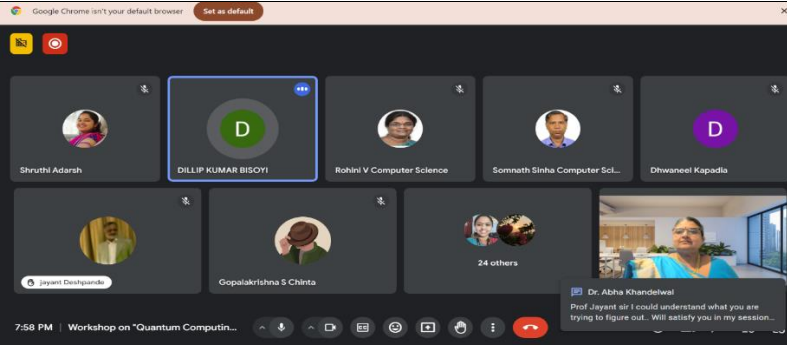
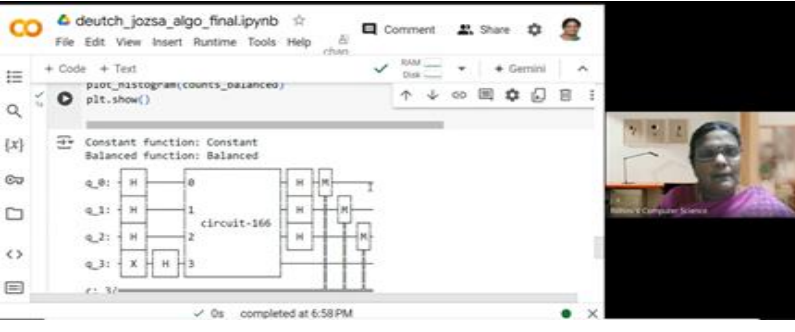
Day 2: 6th August 2024 6:30 to 8:00 PM

		
Master of Ceremony Ms. Shruthi C K	Workshop Convener Dr. Chitra Ravi	Session snapshot
		
Resource person Prof. Dr. Vandna Luthra	Chairperson Dr. S B Kishor	Session Snapshot and participants

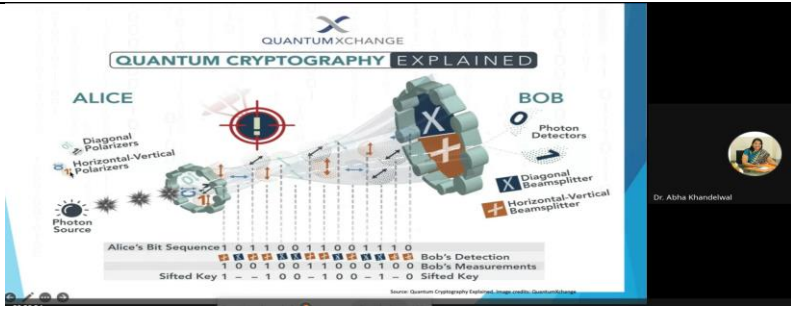
Day 3: 7th August 2024 6:30 to 8:00 PM

	
Dr. Jyoti Ghushe Resource person	Prof. Sarmistha Sahu Chairperson
Quantum Concepts	
Session Screen shot 1	Session screen shot 2

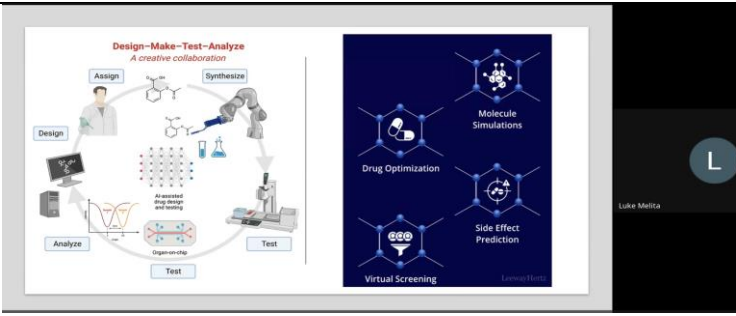
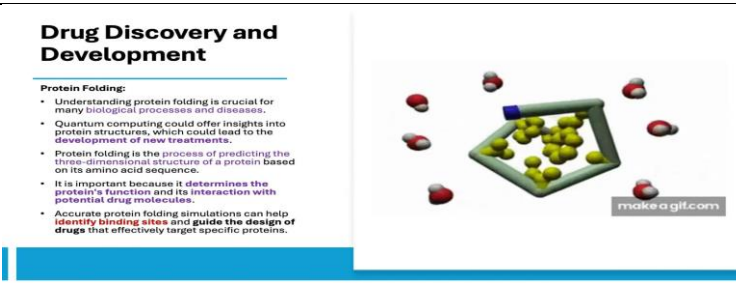
Day 4: 8th August 2024 6:30 to 8:00 PM

	
Dr. Rohini V Resource person	Session participants
	
Dr. Dillip Kumar Bisoyi Chairperson	Session screenshot

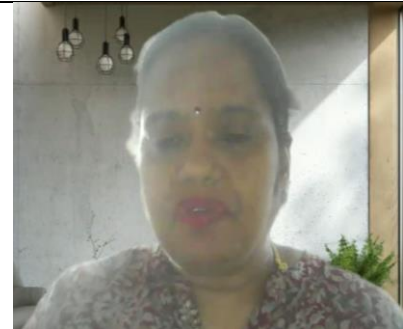
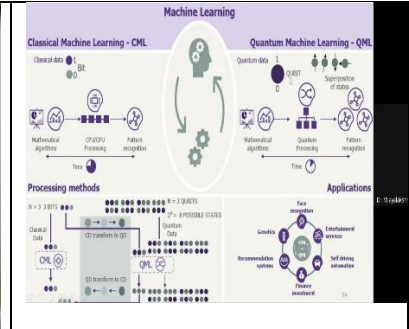
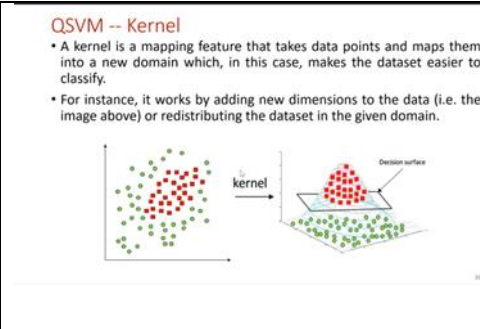
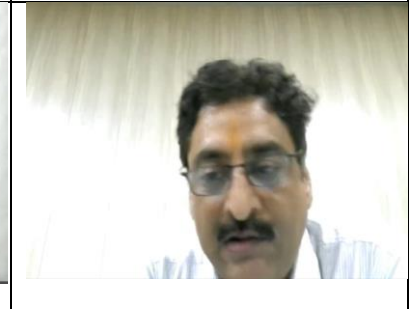
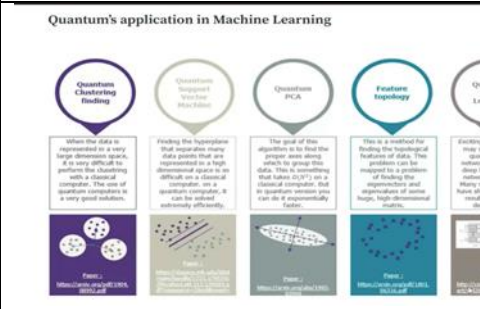
Day 5: 9th August 2024 6:30 to 8:00 PM

 Dr. Abha Khandelwal	
Dr. Abha Khandelwal Resource person	Session screenshot 1
 Dr. Ashish B Sasankar	
Dr. Ashish B Sasankar Chairperson	Session screenshot 2

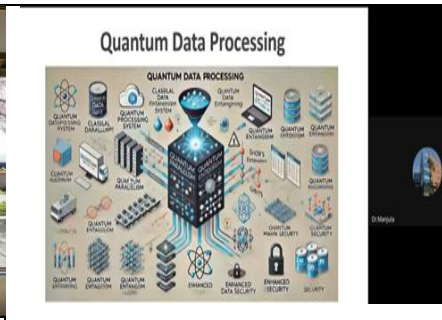
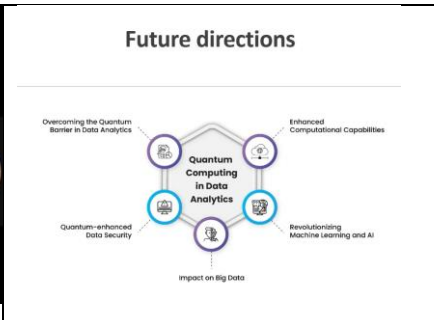
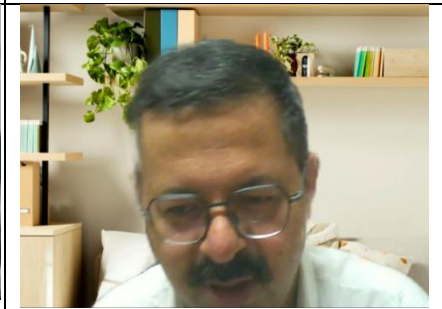
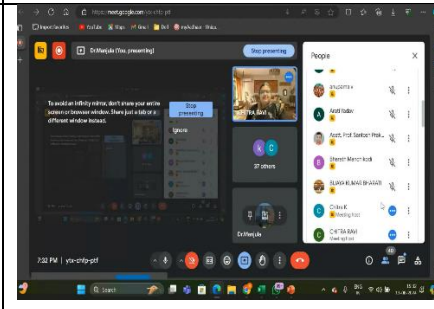
Day 6: 10th August 2024 6:30 to 8:00 PM

 Luke Melita	
Dr. Melita Luke Resource person	Session screenshot 1
	
Session Summary Workshop convener - Dr. Chitra Ravi	Session screenshot 2

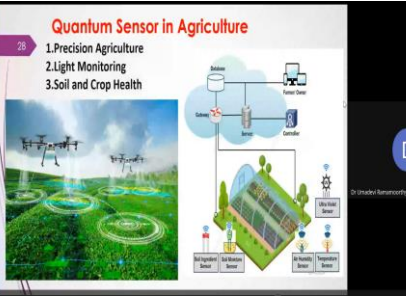
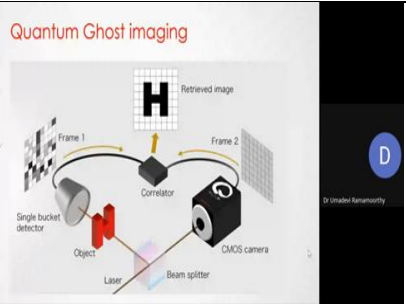
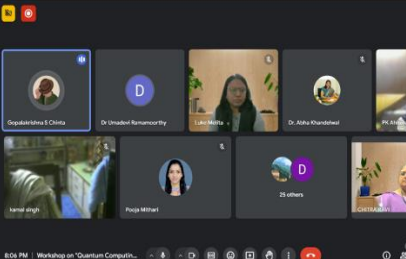
Day 7: 12th August 2024 6:30 to 8:00 PM

		
Dr. Chitra K Master of Ceremony	Session screenshot 1	Session screenshot 2
		
Dr. Vijayalakshmi A Lepakshi Resource person	Dr. Manu Pratap Singh Chairperson	Session screenshot 3

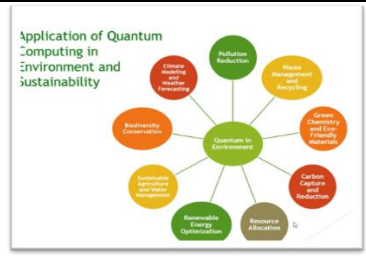
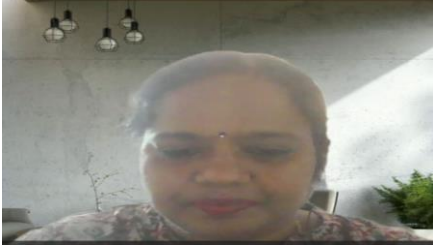
Day 8: 13th August 2024 6:30 to 8:00 PM

		
Dr. Chitra K Master of Ceremony	Session Screenshot 1	Session Screenshot 2
		
Dr. Manjula Sanjay Koti Resource person	Dr. Sumeet Gill Chairperson	Participants

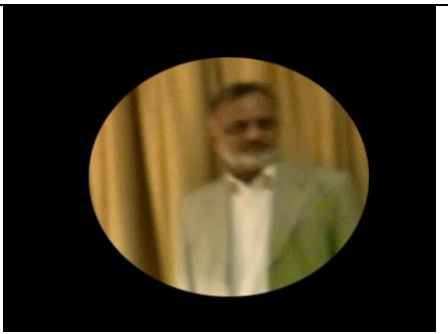
Day 9: 14th August 2024 6:30 to 8:00 PM

		
Dr. Melita Luke Master of Ceremony	Session screenshot 1	Session screenshot 2
		
Dr. Umadevi Ramamoorthy Resource person	Dr. P K Ahluwalia Chairperson	Participants

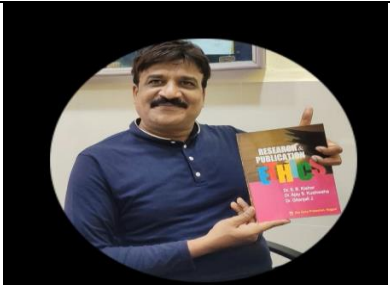
Day 10: 15th August 2024 6:30 to 8:00 PM

		
Dr. Chitra Ravi Master of Ceremony	Session screenshot 1	Session screenshot 2
		
Dr. Chitra K Resource person	Dr. Jigisha Naidu Chairperson	Participants

Day 11: 16th August 2024 6:30 to 8:00 PM

	
Dr. Kumar Chandar Resource person	Session screenshot 1
	
Dr. Jayant Deshpande Chairperson	Session screenshot 2

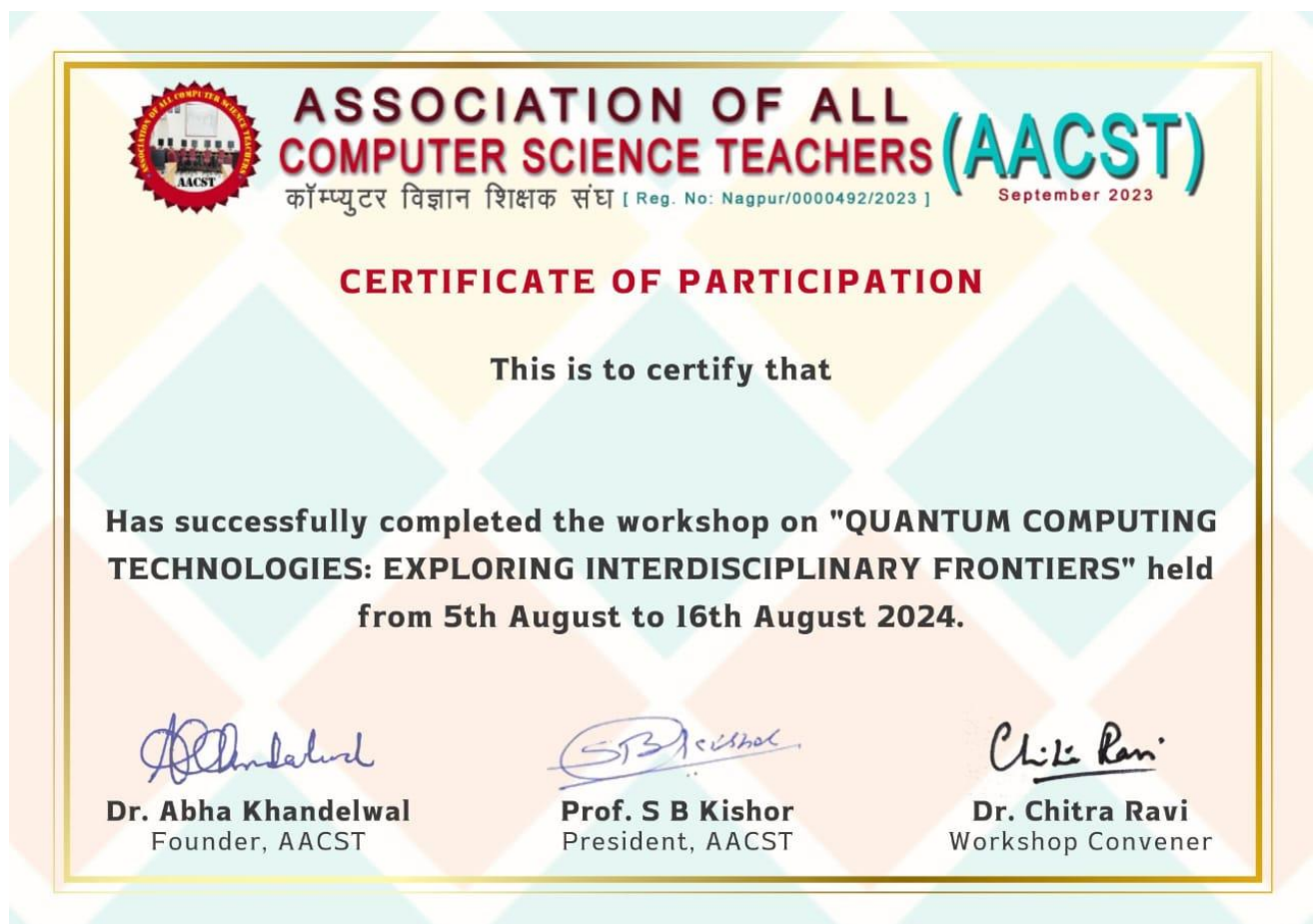
Valedictory Function: 8:00 to 8:30 PM

	
Dr. Chitra Ravi Workshop Convener	Dr. Abha Khandelwal Workshop Mentor
	
Dr. S B Kishor Chief Guest	Dr. Arvind Kulkarni Guest of Honour

Feedback from Participants:



Certificate Design:



Conclusion:

The 11-day national level online workshop on "Quantum Computing Technologies: Exploring Interdisciplinary Frontiers" has been an enriching experience, fostering an in-depth understanding of quantum computing and its far-reaching impact across various disciplines. Throughout the workshop, participants were exposed to the foundational principles of quantum mechanics, the architecture of quantum computers, and emerging quantum algorithms, all while exploring the practical applications and challenges in real-world scenarios.

Key takeaways include:

1. **Foundational Knowledge:** Attendees gained a comprehensive grasp of the underlying mechanics of quantum computing, including superposition, entanglement, and quantum gates, which form the backbone of quantum algorithms.
2. **Interdisciplinary Impact:** The workshop highlighted how quantum technologies can revolutionize multiple fields, such as cryptography, healthcare, drug discovery, Data analytics, Environment and Sustainability, Sensors and imaging, optimization problems, and Finance. The interdisciplinary nature of the discussions opened doors for collaborations across various domains.
3. **Hands-on Learning:** The integration of practical sessions and simulations allowed participants to experiment with quantum algorithms and quantum circuits, thus bridging the gap between theoretical knowledge and practical implementation.
4. **Challenges and Opportunities:** Discussions on the limitations of current quantum computing hardware, error correction, and quantum cryptography provided insights into the challenges that must be overcome for widespread adoption.
5. **Future Directions:** The workshop served as a catalyst for future research, collaboration, and exploration in quantum computing. By addressing quantum computing from an interdisciplinary perspective, the event laid the foundation for ongoing research and development aimed at solving complex problems across various domains.

In conclusion, the workshop has empowered participants to not only understand quantum computing but also recognize its transformative potential across disciplines. The knowledge and skills acquired during these 11 days will equip students, researchers, faculty members and professionals, to contribute meaningfully to the advancement of quantum technologies, thereby pushing the boundaries of what is possible in both academic research and innovation.

Report Prepared By:

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