Dayananda Sagar University
School of Engineering
Bangalore – 560068, Karnataka, India

Report of One-Week FDP

13-02-2023 to 17-02-2023

On

"QUANTUM COMPUTING, TOOLS AND ITS APPLICATIONS"

organized by

Department of Computer Science and Technology

and

Department of Computer Science and Engineering

Quantum Computing is a new disruptive paradigm based on the principle of Quantum Mechanics for solving problems in a variety of scientific fields that go beyond the capabilities of conventional computing infrastructure. Despite many theoretical studies and hardware implementations, the application of quantum computers to solve computational problems has not yet been explored. In the future, a new generation of quantum technologies will drive the development of disruptive devices, services, and systems, primarily affecting imaging and computation of persistent problems and improving network security.

The goal of the FDP was to provide a comprehensive view of quantum computing, its applications, and research possibilities. Distinguished speakers from IISc, CDAC, etc. will give insightful discussions about quantum computing, quantum information, quantum engineering, artificial intelligence & machine learning, and QSim & QISKIT tools. The FDP's target group is faculty, postdocs, and Ph.D. scholars from various well-known institutions.

There were around 55 Participants for this FDP from various colleges along with our DSU faculties who actively participated and 12 Guest speakers were invited to deliver the sessions.

RESOURCE PERSONS

1. Guest Speaker, Prof. Gopalkrishna Joshi, Executive Director, KSHEC.
2. Mr. Henry Sukumar, Joint Director, C-DAC, Bengaluru.
3. Dr. Asvija B, Joint Director, C-DAC, Bengaluru.
4. Ms. Smruthi Jain S B, Technical Program Manager, Geo, Google, Bengaluru.
5. Dr. Satyadhyan Chickerur, Professor, KLE Technological University and Head -Centre for HPC.
6. Dr. Apoorva Patel, Professor, IISc, Bengaluru.

7. Shesha S Raghunathan, Senior Research Scientist - Strategic Partnerships | IBM Quantum | IBM Quantum Ambassador APAC Lead
8. Dr. Subarna Roy, Group-manager in the data-science division, IBM, Bengaluru.
9. Shri. Sridhar Jonnala, Chief Data Scientist & Practice Leader –AI &Analytics, IBM, Bengaluru.
10. Dr. N. S. Vidhyadhiraja, Professor and Dean, Fellowships, and extensions, Theoretical Sciences Unit Jawaharlal Nehru center for advanced scientific Research.
11. Durai Karthi Ganesh, Chief Quantum Architect, BosonQ Psi Pvt Ltd, Bengaluru.
12. Ms. Shikha Mehrotra, Principal Technical Officer, C-DAC, Bengaluru.

LEARNING OUTCOMES OF THE FDP

At the end of this faculty development program, participants will be able to:

- To understand the fundamentals of Quantum Computing, its applications, and research opportunities.
- To understand how Quantum Computing technology can be used in various fields.
- To get familiarized with programming languages and tools used in Quantum Computing.
- To Investigate applications of quantum information concepts in other areas to solve classical problems in computer science and to understand the computational complexity.

PROGRAM SCHEDULE

	Session 1 9.30AM to 11.00 AM	Resource Person	Tea Break 11.00 AM to 11.30AM	Session 2 11.30AM to 1.15PM	Resource Person	Lunch Break 1.15 PM to 2 PM		Resource Person	Tea Break @ 3.30PM
Day 1 (13/02/2023)	Inauguration (9.30 to 10.30AM)	Guest Speaker Prof. Gopalkrishna Joshi Executive Director, KSHEC		Introduction to Quantum Computing	Mr. Henry Sukumar Joint Director C-DAC, Bengaluru. 9886660658 henrys@cdac.in		Quantum Computing for Real world Applications.	Dr. Asvija B Joint Director C-DAC, Bengaluru. 9591146515 asvijab@cdac.in	
Day 2 (14/02/2023)	Quantum Machine Learning	Ms. Smruthi Jain S B Technical Program Manager, Geo, Google, Bengaluru. sbsjain95@gmail.com 8050526348		Approaches for solving problems using Quantum Computing	Dr. Satyadhyan Chickerur Professor, KLE Technological University and Head -Centre for HPC chickerursr@gmail.com 9632601460		DEMO/hands-on on solving problems using Quantum Computing	Dr. Satyadhyan Chickerur Professor, KLE Technological University and Head -Centre for HPC chickerursr@gmail.com 9632601460	
Day 3 (15/02/2023)	Quantum Technology: Directions and Prospects	Dr. Apoorva Patel Professor, IISc, Bengaluru. adpatel@iisc.ac.in Phone: (080)23600569 Mobile: 97412-94802		Overview of Quantum Computing	11:15 – 12:15 1. Shesha S Raghunathan Senior Research Scientist - Strategic Partnerships | IBM Quantum | IBM Quantum Ambassador APAC Lead 2. Dr. Subarna Roy Group-manager in the data-science division, IBM, Bengaluru 3. Shri. Sridhar Jonnala Chief Data Scientist & Practice Leader –AI &Analytics, IBM, Bengaluru. Sridhar (+91 94490 89434)		Basic Quantum algos/ Qiskit hands on	Dr. Subarna Roy, Group-manager in the data-science division, IBM, Bengaluru. subroy12@in.ibm.com	
				Intro to Quantum basics	12:15 - 1:15 pm 4.. Dr. Rajesh Karan Data Scientist / Data Engineer in Advanced Analytics IBM, Bengaluru Rajesh Karan <rajeskar@in.ibm.com>, Shesha S Raghunathan <shesha.raghunathan@in.ibm.com>				
Day 4 (16/02/2023)	The physics of quantum computing: Superposition and Entanglement.	Dr. N. S. Vidhyadhiraja Professor and Dean, Fellowships, and extensions, Theoretical Sciences Unit Jawaharlal Nehru centre for advanced scientific Research raja@jncasr.ac.in 080-22082790 or 9449049650		Quantum Transfer Learning using Pennylane	Durai Karthi Ganesh Chief Quantum Architect, BosonQ Psi Pvt Ltd, Bengaluru. kg.durai@bosonqpsi.com 8123096141		Hands on -Quantum Transfer Learning using Pennylane	Durai Karthi Ganesh Chief Quantum Architect, BosonQ Psi Pvt Ltd, Bengaluru. kg.durai@bosonqpsi.com 8123096141	
Day 5 (17/02/2023)	Introduction to QSim and QSim Algorithm Simulation	Ms. Shikha Mehrotra Principal Technical Officer, C-DAC, Bengaluru. 9986020938 shikham@cdac.in		Introduction to QSim and QSim Algorithm Simulation	Ms. Shikha Mehrotra Principal Technical Officer, C-DAC, Bengaluru. 9986020938 shikham@cdac.in		Quiz: 2PM to 2:30PM Valedictory: 2.30PM to 3:30PM		

Figure 1 Program Schedule

INAUGURATION

The inauguration session started at 9:30 AM with an invocation song sung by Ms. Bhuvana, 3rd sem, CSE student followed by lighting the lamp by the Chief guest Prof. Gopal Krishna Joshi along with other dignitaries. The dignitaries on the stage were Prof. Gopal Krishna Joshi, Executive Director, KSHEC, Honorable Vice Chancellor, Dr. KNB MURTHY, Honorable Pro-Vice Chancellor Dr. Amit Bhatt, Dean Dr. Udaya Kumar Reddy, Dean – Research Dr. M K Banga, Chairperson CST, Dr. M Shahina Parveen, and Chairperson CSE, Dr. Girisha G S.

Figure 2 The dignitaries on the stage

Figure 3 Inaugural session of the FDP

Figure 4 Lighting the lamp

Dr. M Shahina Parveen render the welcome address and introduced Chief Guest. The whole gathering was addressed by Chief guest Prof. Gopal Krishna Joshi, followed by the address of Honorable Vice Chancellor, Dr. KNB MURTHY, and Honorable Pro-Vice Chancellor Dr. Amit Bhatt.

Opening remarks for the FDP were given by Dr. Udaya Kumar Reddy, he also gave a glimpse of the activities going on at Dayananda Sagar University and followed by felicitation of the Chief Guest by all other dignitaries.

Figure 5 Guest Speaker, Prof. Gopalkrishna Joshi delivering the inaugural lecture

Figure 6 Honorable Vice Chancellor, Dr. KNB MURTHY

Figure 7 Honorable Pro-Vice Chancellor Dr. Amit Bhatt

Figure 8 Dean Dr. Udaya Kumar Reddy

Figure 9 Felicitation of the Guest Speaker, Prof. Gopalkrishna Joshi

The inauguration function got over with a vote of thanks given by Dr. Girish G S, Chairperson CSE followed by the National Anthem.

There was a tea break from 11:00 AM to 1:30 AM After the inauguration of FDP.

DAY 1- SESSION 1

Resource persons: **Mr. Henry Sukumar, Joint Director, C-DAC, Bengaluru.**

Details of the session: the speaker delivered a session on Introduction to quantum computing by bringing in the history with wonderful illustrations. He has explained the need for quantum computing and its applications in the real world. He also emphasized use cases.

Figure 10 Mr. Henry Sukumar Joint Director, C-DAC, Bengaluru.

DAY 1- SESSION 2

Resource persons: **Dr. Asvija BJoint DirectorC-DAC, Bengaluru**.

Has delivered a session on Quantum Computing for Real-world Applications in which he briefed about Quantum computing – Different models with examples and explained Grover's Algorithm, Shor's quantum factoring algorithm, and Quantum circuits.

Figure 11 Dr. Asvija BJoint DirectorC-DAC, Bengaluru

Figure 12 Audience interaction

Figure 13 Participants

DAY 2- SESSION 1

Resource persons: **Ms. Smruthi Jain S B Technical Program Manager, Google, Bengaluru** has delivered a session on Quantum machine learning which covered the differences between classical machine learning and Quantum Machine learning. She emphasized Various ML models and Data encoding techniques.

DAY 2- SESSIONS 2 & 3

Resource persons: **Dr. Satyadhyan Chickerur Professor, KLE Technological University and Head – of the Centre for HPC has** delivered a session on QML Approaches for solving problems using Quantum Computing, He has wonderfully presented the emergence of quantum machine learning, Kernel methods, kernel-based training, quantum neural network and given hands-on training to install and use the PennyLane.

Figure 14 Question & answer session

Figure 15 Ms. Smruthi Jain S B Technical Program Manager, Google, Bengaluru

Figure 16 Dr. Satyadhyan Chickerur Professor, KLE Technological University and Head - Centre for HPC

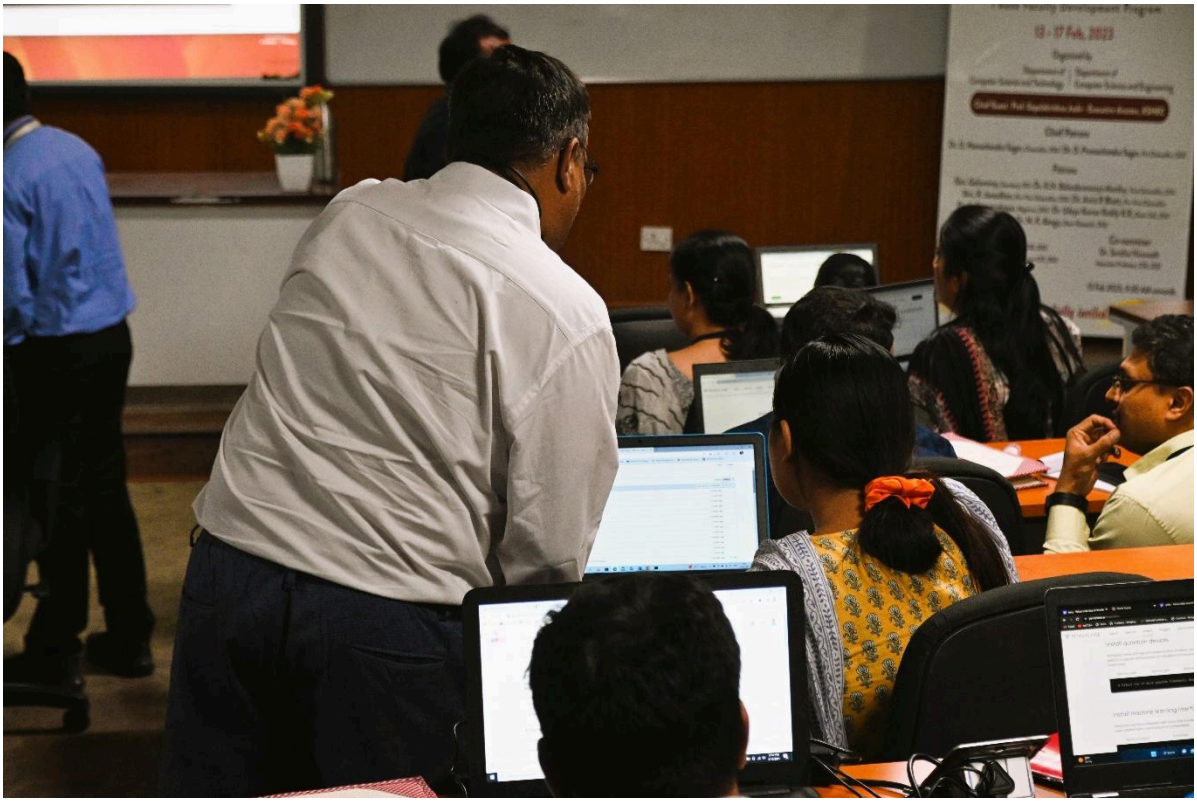
E 

Figure 14 hands-on activities

DAY 3- SESSION 1

Resource persons: Dr. Apoorva Patel, Professor, IISc, Bengaluru who is highly experienced and knowledgeable In the field of Quantum technology he has taken us to the world of Quantum by explaining Moore's law and necessity of linear algebra. Sir also focused on concepts of factorization and suppositions.

Figure 15 Dr. Apoorva Patel, Professor, IISc, Bengaluru

DAY 3- SESSION 2 & 3 handled by the **IBM team were the speakers Rajesh Karan, Sridhar Sesha and Subarna Roy** emphasized on Quantum mechanics, Schrodinger Equation, Copenhagen Interpretation: Bohr, Heisenberg, followed by Hands on session on QISKIT tools for quantum computing.

Figure 16 participants listening to the resource person

Figure 7 Ms. Subarna Roy, IBM, Bangalore

Figure 21 Mr. Sridar Sesha, IBM, Bangalore

Figure 82 Mr. Rajesh Karan, IBM, Bangalore

DAY 4- SESSION 1

Resource persons: Dr. N. S. Vidhyadhiraja Professor and Dean, Fellowships, and extensions, Theoretical Sciences Unit, Jawaharlal Nehru center for advanced scientific Research.

The speaker has given an amazing session on The physics of quantum computing: Superposition and Entanglement.

Figure 23 Dr. N. S. Vidhyadhiraja Professor and Dean, Fellowships, and extensions, Theoretical Sciences Unit, Jawaharlal Nehru center for advanced scientific Research.

DAY 4- SESSION 2 & 3

Resource persons: Durai Karthi Ganesh Chief Quantum Architect, BosonQ Psi Pvt Ltd, Bengaluru delivered an insightful session on Quantum Transfer Learning using Pennylane, he demonstrated Image classification using QTL using PennyLane and use cases to the audience

Figure 9 Mr. Durai Karthi Ganesh Chief Quantum Architect, BosonQ Psi Pvt Ltd

Figure 10 Participants listening to resource person

DAY 5- SESSION 1

Resource persons: Ms. Shikha Mehrotra Principal Technical Officer, C-DAC, Bengaluru has delivered a session on Introduction to QSim and QSim Algorithm Simulation with hands-on.

Figure 11 Ms. Shikha Mehrotra Principal Technical Officer, C-DAC, Bengaluru

According to the schedule, all the sessions were delivered effectively by the respective speakers. Participants had great learning from multidisciplinary experts of quantum computing from reputed industries and academia such as C-DAC, IBM, and IISC. The objectives of this FDP were fulfilled with outcome-based learning and quality knowledge transfer.

An assessment test for 25 marks was conducted as part of OBE for all participants, top three participants were awarded prizes.

VALEDICTORY

The valedictory function of FDP started at 2:30 PM on 17th February 2023 in presence of Chief Guest, Ms. Shikha Mehrotra Principal Technical Officer, C-DAC, Bengaluru, Honorable Pro-Vice Chancellor Dr. Amit Bhatt, Dean Dr. Udaya Kumar Reddy, Chairperson CST, Dr. M Shahina Parveen, and Chairperson CSE, Dr. Girisha G S. It started with an invocation song sung by Dr. K G Madhwaraj, Prof. Dept. of CSE, New Horizon College of Engineering. After that Dr. M Shahina Parveen, chairperson, CST render the report of one-week FDP. It was followed by honoring the Chief Guest.

Prizes for the quiz winners and certificates were distributed to all the participants, volunteers, and organizers by Honorable Pro-Vice Chancellor Dr. Amit Bhatt, Dean Dr. Udaya Kumar Reddy, Chairperson CST, Dr. M Shahina Parveen, and Chairperson CSE, Dr. Girisha G S.

A few participants from different colleges shared their experiences and feedback with the audience. Dr. Savitha Hiremath, Associate Prof. Dept. of CSE, DSU gave a vote of thanks which was followed by the National Anthem.

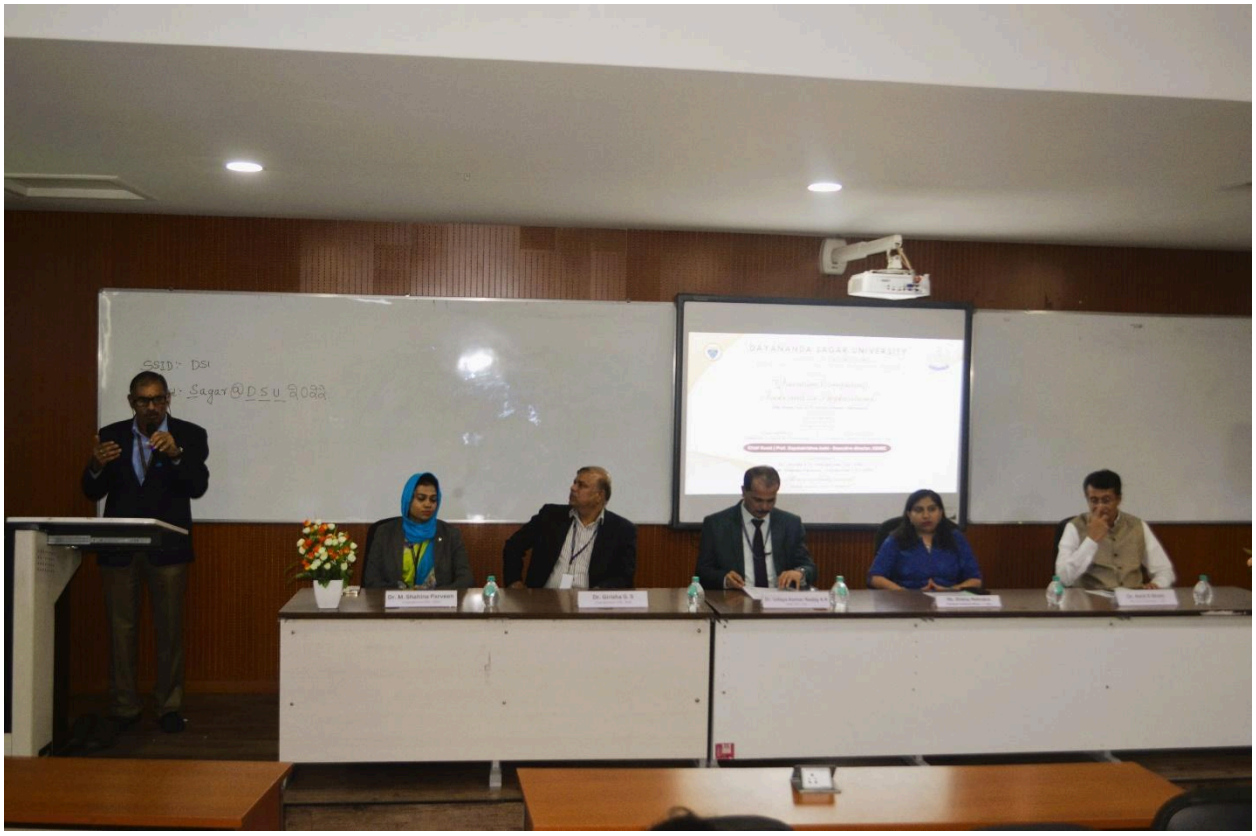


Figure 12 Valedictory Function

Figure 28 Dr. M Shahina Parveen, Chairperson CST, rendering the FDP report

Figure 13 Other college participants receiving a certificate

Figure 14 Quiz winner receiving a certificate

Figure 15 Other college participant receiving a certificate

Figure 16 DSU Participant receiving a certificate

Figure33 Student Volunteer receiving a certificate

Figure 34 Participants sharing their experiences

Figure 38 Dr. Savitha Hiremath giving the vote of thanks

Figure 39 Group photo with all the participants

SAMPLE CERTIFICTES

Dayananda Sagar University

School of Engineering, Kudlu Gate, Bangalore, India

ONE WEEK FACULTY DEVELOPMENT PROGRAM

on

QUANTUM COMPUTING, TOOLS AND ITS APPLICATIONS

CERTIFICATE OF PARTICIPATION

This is to certify that Prof. / Dr. RAMANDEEP KAUR, of DAYANANDA SAGAR UNIVERSITY, has **PARTICIPATED** in **One Week Faculty Development Program** organized by **Department of Computer Science & Technology** and **Department of Computer Science & Engineering** from **13th to 17th February 2023.**

Dr. M Shahina Parveen
Convener
Chairperson, Dept. of CST, SoE
DSU, Bengaluru

Dr. Girisha G S
Convener
Chairperson, Dept. of CSE, SoE
DSU, Bengaluru

Dr. Udaya Kumar Reddy K R
Dean, SoE
DSU, Bengaluru

Figure 40 Participation certificate

Dayananda Sagar University

School of Engineering, Kudlu Gate, Bangalore, India

ONE WEEK FACULTY DEVELOPMENT PROGRAM

on

QUANTUM COMPUTING, TOOLS AND ITS APPLICATIONS

CERTIFICATE OF APPRECIATION

This is to certify that Prof. / Dr. RAMANDEEP KAUR, of **School of Engineering, DSU**, has participated and actively served as a **FACULTY COORDINATOR** for **One Week Faculty Development Program** organized by **Department of Computer Science & Technology** and **Department of Computer Science & Engineering** from **13th to 17th February 2023.**

Dr. M Shahina Parveen
Convener
Chairperson, Dept. of CST, SoE
DSU, Bengaluru

Dr. Girisha G S
Convener
Chairperson, Dept. of CSE, SoE
DSU, Bengaluru

Dr. Udaya Kumar Reddy K R
Dean, SoE
DSU, Bengaluru

Figure 41 Certificate of appreciation

CHIEF PATRONS

Dr. D. Hemachandra Sagar, Chancellor, DSU

Dr. D. Premachandra Sagar, Pro Chancellor, DSU

CONVENERS

Dr. Girisha G. S, Chairperson CSE, DSU
Dr. M. Shahina Parveen, Chairperson CST, DSU
CO- CONVENER
Dr.Savitha Hiremath , Associate Professor, CSE, DSU

ORGANIZING COMMITTEE

Dr. Jayita Saha, Assistant Professor, Dept of CSE.
Prof. Veena M, Assistant Professor, Dept of CSE.
Prof. Shwetha G S, Assistant Professor, Dept of CSE.
Prof. Nandini K, Assistant Professor, Dept of CSE.
Prof. Pooja G, Assistant Professor, Dept of CSE.
Prof. Santhosh H, Assistant Professor, Dept of CSE.
Prof. H Y Ramachandra, Assistant Professor, Dept of CSE.
Prof. Bhaskar Venugopalan, Professor of Practice, Dept Of CST.
Dr. Santosh Kumar, Associate Professor, Dept of CST.
Prof. Ramandeep Kaur, Assistant Professor, Dept of CST.
Prof. Swetha Patil, Assistant Professor, Dept of CST.
Prof. Chithambarathanu, Assistant Professor, Dept of CST.

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