



भारतीय प्रौद्योगिकी संस्थान दिल्ली
Indian Institute of Technology Delhi



Certification in Quantum Computing and Machine Learning (Batch 04)

5 Months | Starts 9th March, 2024 | Live Online Lectures

Prepare for the Quantum Leap

Quantum Computing and Machine Learning merge in a powerful convergence, unlocking the boundless potential of quantum mechanics and data-driven algorithms. Quantum computing propels computations to unimaginable speeds, while machine learning fuels intelligence through data. Together, they amplify processing capabilities, ignite faster training, and unveil transformative insights. This dynamic discipline revolutionises finance, healthcare, cryptography, and beyond.

Global Quantum Computing Market Size



Source: GlobeNewswire

Although stability, scalability, and security pose challenges, collaborative efforts among experts push the boundaries, opening new avenues in computation and Artificial Intelligence (AI). Quantum Computing and Machine Learning reshape industries, fuel innovation, and solve intricate problems. A future awaits, where quantum systems and intelligent algorithms harmonise, unleashing unparalleled problem-solving and groundbreaking scientific discovery. Deep dive into this extraordinary domain where the impossible becomes possible, with IIT Delhi's futuristic Certification in Quantum Computing and Machine Learning Programme.

Certification in Quantum Computing and Machine Learning (Batch 04)

Programme Highlights



A programme from the Department of Electrical Engineering, IIT Delhi; IIT Delhi is ranked #2 in NIRF 2023 (Engineering) and #2 in QS World University Rankings 2024



Five months of immersive online lectures



One-day campus immersion (optional)



Taught by renowned IIT Delhi faculty



E-certificate issued by CEP, IIT Delhi



55 hours of Live Learning (45 hours of live sessions and 10 hours of live tutorials/labs session)

Who Should Attend?

- Learners with a proficiency in Mathematics and Programming, strong passion for emerging technologies, and a desire to be at the forefront of innovation can find great value in exploring the synergies between quantum computing and machine learning.
- Scientists and academics with an interest in cutting-edge technologies can explore the intersection of quantum computing and machine learning to push the boundaries of their research.
- Professionals already working in the field of data science or analytics can expand their expertise by incorporating quantum computing into their toolkit.

Roles and Career Paths in Quantum Computing and Machine Learning Field

- Quantum Software Developer
- Quantum Machine Learning Engineer
- Quantum Data Scientist
- Quantum Consultant

Learning Outcomes



Learn the principalities and nuances of quantum computing



Understand the differences between conventional computing and quantum computing



Get equipped with various quantum computing algorithms



Build a strong foundation in the applications of Quantum Computing and Machine Learning



Access to the latest industry insights

Programme Curriculum

Module 1: Introduction to Quantum Computing

- Quantum Bits
- Dirac Notation
- Single and Multiple Qubit Gates
- No Cloning Theorem
- Quantum Interference

These learning outcomes provide students with a thorough understanding of the key topics covered in Module 1, enabling them to work with qubits, quantum gates, Dirac notation, and understand the foundational principles of quantum computing.

Module 2: Postulates of Quantum Computing

- Quantum State
- Quantum Evolution
- Quantum Measurement
- Bell's Inequality Test
- Density Coding
- Quantum Teleportation
- BB84 Protocol
- Quantum Error Correction

By the end of this module, students will have a solid grasp of the foundational concepts in quantum computing and be able to apply these principles to solve real-world problems and design quantum algorithms.

Module 3: Introduction to Quantum Algorithms

- Qiskit
- Deutsch-Jozsa Algorithm Implementation
- Bernstein-Vajirani Algorithm
- Simon's Algorithm

By the end of this module, students will have a solid foundation in quantum algorithms. They will be proficient in using Qiskit and have hands-on experience in implementing key quantum algorithms, including Deutsch-Jozsa, Bernstein-Vazirani, and Simon's algorithms. This knowledge will enable students to apply quantum algorithms to solve problems efficiently and understand their quantum advantage in specific use cases.

Programme Curriculum

Module 4: Quantum Fourier Transform and Related Algorithms

- Quantum Fourier Transform
- QFT Implementation in Qiskit
- Quantum Phase Implementation
- Quantum Phase Estimation in Qiskit
- Shor's Period Finding Algorithm
- Grover's Search Algorithm

By the end of this module, students will have a comprehensive understanding of the Quantum Fourier Transform and its applications in quantum algorithms. They will be proficient in using Qiskit to implement these algorithms and tackle real-world problems in quantum computing, including cryptography and search tasks.

Module 5: Quantum Machine Learning

- Data Encoding
- HHL Algorithm
- HHL Algorithm Implementation
- Quantum Linear Regression
- Quantum Swap Test Subroutine
- Swap Test Implementation
- Quantum Euclidean Distance Calculation
- Quantum K-Means Clustering
- Quantum Principal Component Analysis
- Quantum Support Vector Machines
- SVM Implementation Using Qiskit

By the end of this module, students will have a solid grasp of quantum machine learning techniques and their practical implementation. They will be equipped with the skills to use quantum algorithms for data encoding, linear system solving, regression, clustering, dimensionality reduction, and classification, ultimately enhancing their ability to address complex machine learning challenges.

Programme Curriculum

Module 6: Quantum Deep Learning

- Hybrid Quantum-Classical Neural Networks
- Classification Using Hybrid Quantum-Classical Neural Network
- Quantum Neural Network for Classification on Near-term Processors

By the end of this module, students will have a strong understanding of quantum deep learning concepts and practical implementation. They will be able to design, train, and evaluate hybrid quantum-classical neural networks for classification tasks, especially on near-term quantum hardware, enhancing their capabilities in quantum-enhanced machine learning and deep learning.

Module 7: Quantum Variational Optimisation and Adiabatic Methods

- Variational Quantum Eigensolver
- Expectation Computation
- Implementation of the VQE Algorithm
- Quantum Max-Cut Graph Clustering
- Quantum Adiabatic Theorem
- Quantum Approximate Optimisation Algorithm
- Quantum Algorithm for Finance

By the end of this module, students will have a comprehensive understanding of quantum variational optimization techniques and adiabatic methods. They will be able to implement quantum algorithms like VQE, QAOA, and apply them to solve problems in quantum chemistry, graph clustering, optimization, and finance. This knowledge will empower students to leverage quantum computing for practical problem-solving across various domains.

Tools



Qiskit based programming

Projects

Project Name

Hybrid Quantum Neural Networks for Remote Sensing Imagery Classification

Analysis and Implementation of Quantum Encoding Techniques

Quantum Convolutional Neural Network for Classical Data Classification

Prediction of Solar Irradiation Using Quantum Support Vector Machine Learning Algorithm

To Solve Any Combinatorial Optimisation Problem (Like Knapsack) Using a Quantum Annealing Approach

Comparative Study of Data Preparation Methods in Quantum Clustering Algorithms

To Calculate the Ground State Energy of a Simple Molecule (H₂, LiH, or H₂O) Using VQE

Variational Quantum Classifier

Implementing Grover's Algorithm and Proving Optimality of Grover's Search (Bounded Error and Zero Error)

To Implement Grover's Search Algorithm Where 1101 Is the Marked State

Quantum Computing for Finance

To Solve Crop-Yield Problem Using QAOA and VQE, and Run the Same on Real Quantum Computer

Analysis of Solving Combinatorial Optimisation Problems on Quantum and Quantum-like Annealers

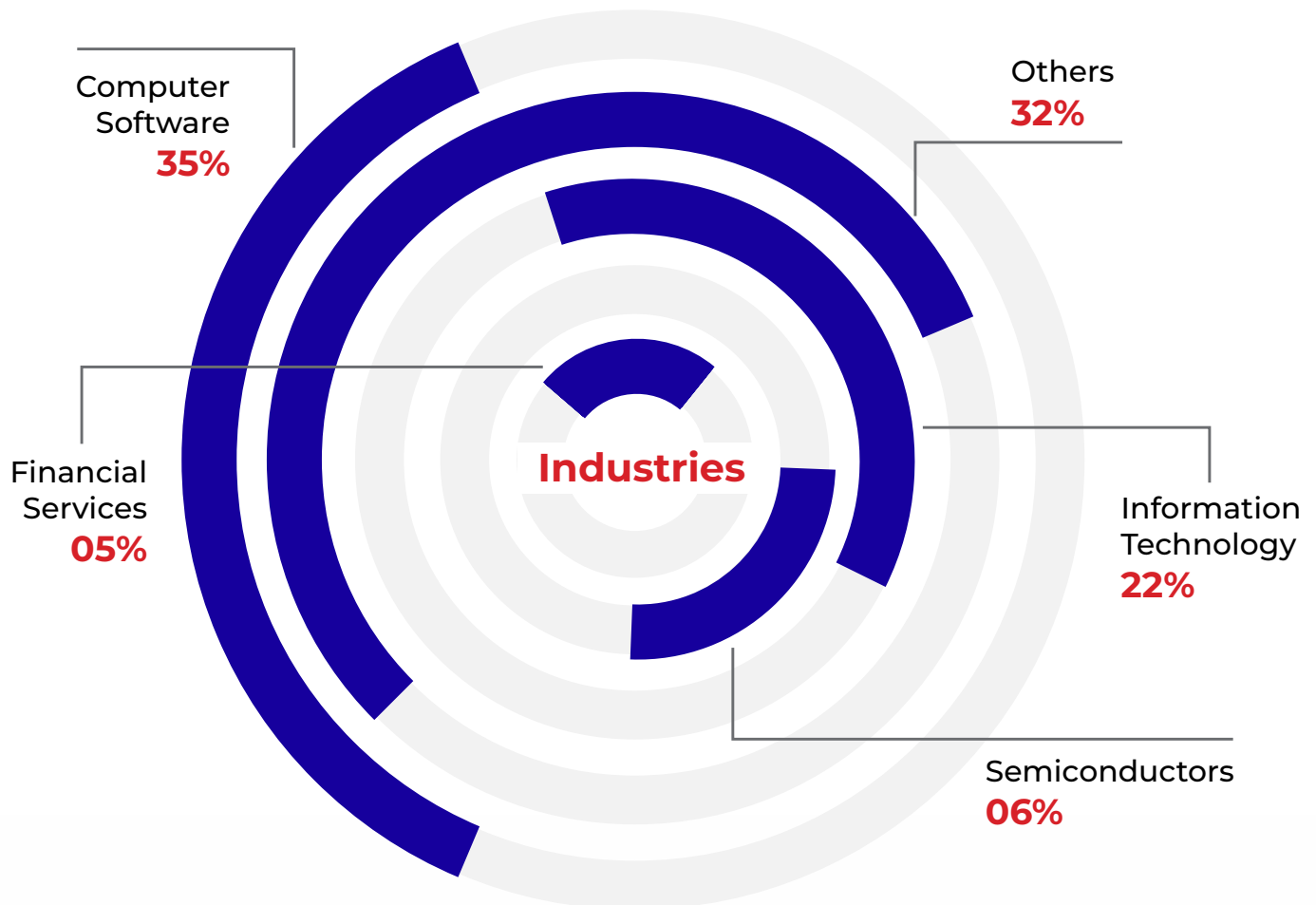
Quantum Convolutional Neural Network for Classical Data Classification

Research on Quantum Computing Usage to Expedite the Drug Discovery Process (Life Sciences).

To Implement Shor's Code in Qiskit with Noise Models
To Understand and Implement Quantum Counting

Enterprise Intelligence - Managed Services with Quantum Computing
On-ground Implementation of Quantum Key Distribution in Indian Navy
Implementing MC Simulations Using Quantum Algorithm (Financial domain)
To Design and Build an Educational Game Using Fundamentals of Quantum Computing
Solving Travelling Salesman Problem Using QAOA
Implementing Clinical Data Classification by Quantum Machine Learning (QML)
To Understand and Implement Quantum Carry-Save Arithmetic
Implementing Any One Quantum Algorithm and Understanding Classical vs Quantum Hardness of Problems
To Implement Shor's Algorithm to Factor 49
To Understand and Implement Grover Search-Based Algorithm for the List Coloring Problem
Optimisation Problem Where We Try to Find the Best Solution to Coal Overburden Problem with Depth and Coal Quantity Mined
Implementing HHL Algorithm and Proving BQP-completeness of Matrix Inversion
Quantum Convolutional Neural Network-based Medical Image Classification
Quantum Convolutional Neural Network
Quantum Computing for Finance
Tentative Title: Differential Detection of Internal Fault of an Electrical Network: A Comparison with Classical vs Quantum Approach Major Area: Implementing Any One Quantum Algorithm and Understanding Classical vs Quantum Hardness of Problems
Quantum Computing and Information Security
Feature Selection in Machine Learning Using Quantum Computing

Past Participants Profile



*Others include Computer Hardware, Education Management, Health Care, Banking, Industrial Automation, Management Consulting and Insurance, amongst others.

Testimonials

ALEKHA

"Enrolling in this course was an enlightening journey that opened my mind to the fascinating realm of quantum computing and its applications to machine learning. The instructor's expertise and passion for the subject were truly inspiring."

SATINDER

"Quantum Computing course by IIT Delhi, served by Times Pro, is exceptional! In a short term, I gained a solid understanding of complex concepts. Brilliant instructors, practical insights, and engaging discussions."

Programme Details



Eligibility Criteria

Graduation with a minimum of 50% in any of the disciplines: B.Tech/BE; BCA/MCA; B.Sc in all streams; BA in mathematics.



Delivery

Live Online Sessions delivered Direct to Device (D2D)



Duration

55 Hours of Live Learning
- 45 hours of live sessions
- 10 hours of live tutorials/labs sessions

Note: Doubt clarification and lab practise sessions may be conducted.



Class Schedule

Saturday & Sunday:
02:00 PM – 03:30 PM



Admission Criteria

Selection based on application review



Campus Immersions

1 day for interaction with candidates at IIT Delhi(optional).



Assessment & Evaluation

- 60% - Module tests/quizzes
- 30% - Projects
- 10% - Attendance

6 tests/quizzes will be held after the completion of each module, from 2nd module onwards.



Certification*

- Candidates who score at least 50% marks overall and have a minimum attendance of 40%, will receive a 'Certificate of Successful Completion' from CEP, IIT Delhi.
- Candidates who score less than 50% marks overall and have a minimum attendance of 40%, will receive a 'Certificate of Participation' from CEP, IIT Delhi.
- The organising department of this programme is the Department of Electrical Engineering, IIT Delhi.



**Only e-Certificates will be issued by CEP, IIT Delhi for this programme.*

Programme Coordinator



DR. ABHISHEK DIXIT

Associate Professor,
Department of Electrical Engineering,
Indian Institute of Technology Delhi

Dr. Abhishek Dixit received his M.Tech. degree in Opto-electronics and Optical Communication from the Indian Institute of Technology (IIT) Delhi in 2010 and his Ph.D. degree in Computer Science Engineering from the Department of Information Technology (INTEC), Ghent University, Belgium, in 2014. Since 2015, he has been an Assistant Professor at IIT Delhi, where he has taught courses related to Optical Communications, Signal Processing, Communications Engineering, and Networking. Recently, he started actively researching the use of Machine Learning to improve the performance of conventional and quantum communications systems. He has also taken an NPTEL course on the Principles of Digital Communications. Before joining IIT Delhi in December 2015, he served for a semester (July 2015 – December 2015) as an Assistant Professor at IIT Mandi and as a Post-doctoral Researcher (December 2014 – June 2015) at Ghent University, Belgium. He is leading research activities at IIT Delhi in the area of Optical Communications and Networking. In this context, he has been involved in a large number of Indian projects. He has also carried out several consultation projects in the area of railway signalling. He has published over 30 international journal articles (IEEE JSAC, IEEE Communications Magazine, Journal of Lightwave Technology, Journal of Optical Communications and Networking, IEEE Networks, IEEE Transactions on Network and Service Management, IEEE Access, IEEE Sensors, IEEE Open Journal of the Communications Society, etc.) and over 50 publications in international conferences.

Programme Fee

Particulars	Amount (₹)
Program Fees	1,50,000
GST @18%	27,000
Total Fees	1,77,000

All fees should be submitted in the IITD CEP account only, and the details will be shared post-selection.

Note:

- The receipt will be issued by the IIT Delhi CEP account for your records.
- Easy EMI options available.
- Loan and EMI Options are services offered by TimesPro. IIT Delhi is not responsible for the same.

Instalment Schedule

Instalment	Instalment Date	Amount (₹)*
I	Within one-week of offer roll-out	60,000
II	10 th May, 2024	45,000
III	10 th June, 2024	45,000

**GST @18% will be charged extra in addition to the fee.*

Programme Timelines

Application Closure Date	21 st December, 2023
Programme Start Date	9 th March, 2024
Programme End Date	August 2024

APPLY NOW 



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Indian Institute of Technology Delhi



The Indian Institute of Technology Delhi (IIT Delhi) is one of the 5 initial IITs established for training, research and development in science, engineering and technology in India. Established as the College of Engineering in 1961, the Institute was later declared an Institution of National Importance under the "Institutes of Technology (Amendment) Act, 1963" and was renamed as "Indian Institute of Technology Delhi". It was then accorded the status of a Deemed University with powers to decide its own academic policy, conduct its own examinations and award its own degrees. Since its inception, over 48,000 students have graduated from IIT Delhi in various disciplines including Engineering, Physical Sciences, Management and Humanities & Social Sciences.

For more details, please visit: www.iitd.ac.in

Continuing Education Programme (CEP)



Executive education is a vital need for companies to build a culture that promotes newer technologies and solutions and builds a workforce that stays abreast of the rapidly transforming needs in the technological, business and regulatory landscape. Committed to the cause of making quality education accessible to all, IIT Delhi has launched Online Certificate Programmes under eVIDYA@IITD (ई-विद्या @IITD), enabling Virtual and Interactive learning for Driving Youth Advancement @IITD for Indian as well as international participants.

These outreach programmes offered by the Indian Institute of Technology Delhi (IIT Delhi) are designed to cater to the training and development needs of various organisations, industries, society and individual participants at national and international levels with a vision to empower thousands of young learners by imparting high-quality Online Certificate Programmes in cutting-edge areas for their career advancement in different domains of engineering, technology, science, humanities and management.

For more details, please visit: <http://cepqip.iitd.ac.in>

2nd
in NIRF Ranking 2023
(Engineering)

2nd
in Outlook ICARE Rankings
2023 (Engineering)

2nd
in QS World University
Rankings 2024 in India

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www.timespro.com



Online Certificate Programmes are offered by the Indian Institute of Technology Delhi under the aegis of Continuing Education Programme (CEP) so that the Institute can realise its vision of serving as a valuable resource for industry and society and fulfil its mission to develop human potential to its fullest extent so that intellectually capable and imaginatively gifted leaders can emerge in a range of professions.