भारतीय प्रौद्योगिकी संस्थान दिल्ली
Indian Institute of Technology Delhi

Certification in Quantum Computing and Machine Learning (Batch 05)

6 Months | Starts 28th September, 2024 | Live Online Lectures

Programme offered by Continuing Education Programme (CEP), IIT Delhi

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 05)

Programme Highlights

- Comprehensive coverage of quantum computing and quantum machine learning
- Taught by renowned IIT Delhi faculty
- Live tutorials and lab practice sessions
- Doubt clearing sessions
- One-day campus immersion

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.

Job Roles

Below are the job roles available in this field:

Quantum Software Developer:

Responsible for designing, implementing, and optimising quantum algorithms and software applications using quantum computing platforms. They ensure the software leverages quantum mechanics to solve complex problems more efficiently than classical methods.

Quantum Machine Learning Engineer:

Develops and integrates machine learning models with quantum computing techniques to enhance computational capabilities. Their role involves experimenting with quantum algorithms to improve data analysis, pattern recognition, and predictive modeling.

Quantum Data Scientist:

Applies quantum computing to process and analyse large datasets, discovering insights and patterns not feasible with classical computing. They design quantum experiments and interpret results to inform business decisions and scientific research.

Quantum Consultant:

Provides expert advice on the potential applications and benefits of quantum computing to businesses and organisations. They evaluate current systems, recommend quantum solutions, and assist in the implementation and integration of quantum technologies.

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

Students will be equipped 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 optimisation 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
Comparitive 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 Convulational 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
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
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

Career Support

Personal Branding	• Introduction to networking platforms • Profile creation on professional networking • platforms like LinkedIn, Lunchclub, etc. • LinkedIn Profile Review • How to create personal brand presence on LinkedIn? • How to increase post engagement on LinkedIn? • Active networking
Business Communication	• Role and importance of effective communication as a leader • The art of providing constructive feedback for • successful team • Importance of non-verbal communication • Key elements of executive body language
Job Search Strategy	• **Resume Creation** • Importance of creating ATS friendly executive resume • Executive resume sections and structure • Tailoring resumes for different roles and industries • Write a powerful resume that stands out from the competition • **Resume Review** - Peer to peer review and Q&A
Interview Preparation	**Pre-interview Etiquettes** • Learn about top-down approach for interviews • Pre-interview tips and tricks **In-interview Etiquettes** • Create a self-elevator pitch • Understanding interviewer mindset • Interview grooming sessions and tips and tricks for interview **Post-interview Etiquettes** • Reflecting on interview experience and incorporating the feedback • Relationship building with the recruiter • Learn how to follow up on your job application

Note: Career support facility is offered by TimesPro. IIT Delhi is not responsible for the same.

Programme Details

Eligibility Criteria

Graduation/Postgraduation in Science, Technology, Engineering or Mathematical Sciences

Delivery

Live Online Sessions delivered
Direct to Device (D2D)

Duration

6 Months

- 45 hours of live sessions
- 45 hours self-paced session recordings
- 10 hours of live tutorials/labs sessions
- 6 hours campus immersion

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

Class Schedule

Saturday and Sunday:
8:30 am - 10:00 am

Admission Criteria

Selection based on application review

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.

Campus Immersion

There will be an optional one-day campus immersion for interaction between faculty and learners in IIT Delhi campus.








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 Bharti School of Telecommunication Technology and Management, 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.

Testimonials

ABHIJEET KUMAR

Director, Data Science
Fidelity Investments

This course would benefit anyone who wants to understand fundamentally the quantum space. As a data scientist, I liked the quantum machine learning module where we got exposed to how ML models are trained using quantum techniques/hardware. Most of the topics/algos showing quantum advantage was super interesting to be aware of. One should pursue the course to solve real problems/application using quantum considering the state where quantum computing exists as of now.

DEEPTI VAIDYULA

Principal QA Engineer
Altir

The TimesPro interface for learning is very convenient. I really liked the cloud recordings that are provided. Any issues that we had were sorted promptly. I have taken the QCML-03 course, and the lectures were very detailed. The MCQ's and project work made us put the effort that's needed. I would highly recommend the courses offered via TimesPro + IIT to others.

RAJESH SAHASRABUDDHE

Principal Consultant- NFT marketplace
Rezoomex

Great course content, top class delivery and good service by TimesPro, they were always prompt in responding to queries and also resolved them in time. So overall very happy with the course.

Testimonials

VIJAY KARTHIK

AVP
JPMC

The course starts from ground zero and builds up to a level where you begin to get a good grasp of what quantum computing is and how it is going to disrupt machine learning. It is conducted by IITD Prof. and has great learning value!

ALEKHA BHATT

Tech Architecture Analyst
Accenture

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 SINGH

Solutions architect
Violetpath Technologies

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

Programme Fee

Particulars	Amount (₹)
Programme Fee	1,69,000
GST @18%	30,420
Total Fees	1,99,420

Note:

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

Withdrawal & Refund from Programme

- Candidates can withdraw within 15 days from the programme start date. A total of 80% of the total fee received will be refunded. However, the applicable tax amount paid will not be refunded on the paid amount.
- Candidates withdrawing after 15 days from the start of the programme session will not be eligible for any refund.
- If you wish to withdraw from the programme, you must email cepaccounts@admin.iitd.ac.in and icare@timespro.com, stating your intent to withdraw. The refund, if applicable, will be processed within 30 working days from the date of receiving the withdrawal request.

Instalment Schedule

Instalment	Instalment Date	Amount (₹)**
Registration Fee*	To be paid at the time of registration	10,000
I	Within one week of offer roll-out	59,000
II	12th November, 2024	50,000
III	27th December, 2024	50,000

Note:

- *Registration fee of ₹10,000 will be charged for processing the selected applications only, post confirmation email from the institute. The registration fee is also part of the total programme fee.
- An offer letter from CEP, IIT Delhi will be released post the successful receipt of
- the Registration Fee.
- **GST@ 18% will be charged extra in addition to the fee.

Programme Timelines

Application Closure Date	8th September, 2024
Programme Start Date	28th September, 2024
Programme End Date	February 2025

APPLY NOW

भारतीय प्रौद्योगिकी संस्थान दिल्ली
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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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.