ANDHRA PRADESH STATE COUNCIL OF HIGHER EDUCATION

(A Statutory Body of the Government of A.P.)

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To
All the Vice Chancellors of the State Universities.
All the Principals of all affiliated colleges in the state.

Sir / Madam,

Sub: Establishment of Quantum Innovation Centres (QICs) in Colleges - Guidelines - Issued – Reg.

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Greetings from APSCHE. On this auspicious day, I take it a pleasure to empower our faculty and students in line with the vision of strengthening research, innovation, and workforce development in emerging areas of quantum science and technology, all affiliated colleges are hereby directed to establish Quantum Innovation Centres (QICs). These centres will serve as hubs of expertise, education, and research, with access to IBM Quantum resources and Qiskit-based training modules.

The detailed guidelines for the establishment and functioning of QICs are enclosed herewith. Universities and Colleges are requested to make necessary arrangements for infrastructure, faculty training, academic integration, and research collaborations, as per the roadmap provided in the guidelines.

Action Points for Colleges:

- Identify faculty members to be trained in Python, Qiskit, and IBM Quantum Cloud.
- Set up a dedicated lab with IBM Quantum Cloud access.
- Introduce certificate courses offered by IBM
- Organize workshops, hackathons, and student exchange activities.
- Establish collaborations with industry, startups, and other higher education institutions.
- Submit a quarterly progress report to the AP State Council of Higher Education for review.

The cooperation of all colleges and universities in implementing these initiatives is solicited. This step will ensure that our students and faculty remain at the forefront of the global quantum technology ecosystem.

With regards,

Yours faithfully,
K. Madhu Murthy
CHAIRMAN

Encl: Guidelines for Establishing Quantum Innovation Centres (QICs) in colleges & universities

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Guidelines for Establishing Quantum Innovation Centres (QICs) in Universities and Colleges

Quantum Innovation Centers (QICs) serve as elite centers of expertise in the growing and ever-changing quantum ecosystem. Many operate as a hub, an industry leader growing a quantum community by partnering with IBM directly, and serving as a central contact point for other organizations. This community might be centered on a particular specialization within quantum computing, or sometimes it may be built around a certain geographic location. QICs are providing geographically-optimized quantum communities all over the world.

This kind of community building, around an IBM QIC, has the potential to meet local needs through a bottom-up approach, to offer a wider variety of quantum computing access plans, and to leverage the community for broader expertise. This can be especially important for smaller organizations and startups. Being an IBM QIC establishes your leadership in the field, builds important industry connections, and it grows and opens up the quantum community. Another important consideration is that the resulting collaboration could facilitate more competitive applications for governmental and private funding.

What it means to be a QIC

There are many reasons for starting a Quantum Innovation Center. One common theme is the need for a community of expertise, for which a QIC can be a powerful catalyst. In the video below, our speakers who represent QICs will tell us what it means to them to be an IBM Quantum Innovation Center.

Key points

- QICs have a sense of obligation to industry partners, as well as to students (who are the emerging quantum workforce), and to society.
- QICs are at the forefront of quantum technology.
- QICs are often focused on partnerships within a specific geographic region.
- QICs derive great value from the IBM Quantum Network, and the communities they, themselves form.

These elements of being a QIC, and the reasons behind them, will play a role as we discuss goals and measures of success in later sections. In the next section, we will give a high-level overview of common developmental stages for a quantum team. Then we'll dive deeper into each part of the process, through discussions with the people who know best: leaders of successful IBM Quantum Network partners!

Functions of QICs in HEIs:

Training on Python
Training on Qiskit
Training on IBM Quantum Cloud
Practical Quantum Computing with IBM Qiskit for Beginners
Quantum Computing with Qiskit and Advanced Algorithms
The Complete Quantum Computing Course for Beginners Specialization
Quantum Computing For Everyone - An Introduction
Python Programming for Quantum Computing

Hello world | IBM Quantum Documentation

Tutorials

Use these tutorials to learn how to apply Qiskit to common quantum computing use cases.

- Start with the set of tutorials in the Get started section if it is your first time running code on a quantum computer.
- The section on workflows toward advantage contains end-to-end examples of using a quantum computer to solve real-world problems. These tutorials focus on algorithms that are promising candidates for achieving computational advantage by a quantum computer over a classical computer.
- The section on Qiskit capabilities contains examples that use the latest and most advanced techniques in the Qiskit ecosystem to improve part or the whole of a particular workflow.

Explore workflows toward advantage

Tutorials in this section cover large-scale demonstrations of quantum algorithms.

Verifiable sampling algorithms

The algorithms in this category focus on quantum circuits whose output distributions encode solutions to structured problems with verifiable output. Verifiability means that you can check the consistency between measured data, either through evaluating the chosen bitstring or by knowing that false positives do not occur.

The tutorials highlight techniques where repeated sampling enables estimation of problem-specific quantities (for example, cost function values or spectral weights). These methods are particularly relevant for optimization and simulation tasks with symmetries.

- Sample-based quantum diagonalization of a chemistry Hamiltonian
- Sample-based Krylov quantum diagonalization of a fermionic lattice model
- Quantum approximate optimization algorithm

- Advanced techniques for QAOA
- Pauli Correlation Encoding to reduce Maxcut requirements

Observable estimation
These tutorials focus on estimating physically meaningful quantities, such as energy or correlation values, by preparing quantum states and measuring observables. Techniques include both variational and Trotterized circuit approaches that balance circuit expressiveness with circuit-depth efficiency. Emphasis is placed on workflows that reduce quantum resource demands while maintaining accuracy, and enabling practical estimation of observables in chemical and physical systems.

- Krylov quantum diagonalization of lattice Hamiltonians
- Nishimori phase transition
- Ground state energy estimation of the Heisenberg chain with VQE
- Quantum kernel training
- CHSH inequality

Fault-tolerant algorithms
This section features algorithms with well-defined theoretical guarantees that are designed to run on future error-corrected quantum hardware. The circuits or sampling overhead for these algorithms scale in a manner that is not depth-efficient and are thereby are more likely to demonstrate quantum advantage when fault-tolerant quantum computers exist. These tutorials illustrate how the methods operate in idealized settings and demonstrate small scale examples.

- Shor's algorithm
- Grover's algorithm

Leverage Qiskit capabilities
This section introduces advanced capabilities within the Qiskit ecosystem that enhance performance, reliability, and speed when executing quantum algorithms.

Workload optimization
Workload optimization focuses on either efficient orchestration of classical and quantum resources or tailored methods for improving quantum circuit manipulation.

- Introduction to fractional gates
- Qiskit AI-powered transpiler service introduction
- Transpilation optimizations with SABRE
- Compare transpiler settings
- Compilation methods for Hamiltonian simulation circuits
- Long-range entanglement with dynamic circuits

Qiskit Functions
Qiskit Functions are a collection of pre-packaged error management and application tools, making it easy to design large-scale experiments with circuits, molecules, QUBOs, and more.

- Design new algorithms with **Circuit functions** -- with pre-built transpilation, error suppression, and error mitigation pipelines.

    - Error mitigation with the IBM Circuit function

- Experiment with domain-specific problems with **Application functions** -- with familiar inputs and outputs to classical solvers.

    - Quantum Portfolio Optimizer - A Qiskit Function by Global Data Quantum
    - Higher-order binary optimization with Q-CTRL's Optimization Solver
    - Model a flowing non-viscous fluid using QUICK-PDE
    - Dissociation PES curves with Qunova HiVQE

Qiskit addons
Addons enable advanced circuit manipulation, such as cutting, backpropagating observables, or approximating circuits, that allow users to sidestep hardware limitations at the cost of increased classical compute overhead.

- Multi-product formulas to reduce Trotter error
- Approximate quantum compilation for time evolution circuits
- Operator backpropagation (OBP) for estimation of expectation values
- Wire cutting for expectation values estimation
- Circuit cutting for periodic boundary conditions
- Circuit cutting for depth reduction

Error mitigation
Error mitigation addresses the challenge of noise without full fault tolerance by recovering accurate expectation values through controlled circuit manipulation and post-processing.

- Utility-scale error mitigation with probabilistic error amplification
- Combine error mitigation options with the Estimator primitive
- Real-time benchmarking for qubit selection

Error detection
Error detection identifies faulty operations to return noise-free results shot-by-shot by post-processing.

Repetition codes
Keynote 1 Nate Ernest Noble
https://youtu.be/bfutQnmRlEs?si=7nogdnrlcK2TNjQJ
https://youtu.be/G9wux54EUyQ?si=LiosjXw8HJ5CW8Wn

Integrate UG Teaching Labs on QT for effective functioning of QICs in Colleges and take up the following activities for an outcome based approach.

Education and Workforce Development
Adapt Classrooms to a rapidly changing field

Ecosystem Development
Attract Partners in the region, Develop Ecosystem Pipeline

Quantum as a Tool
Access latest tools for top quality research, integrate into workflow for easy access

Research and Development
Establish, maintain and expand leadership in research

Focus on new techniques in Qiskit to improve workflows
Approximate Quantum compilation for time evolution circuits (AQC)
Multi-product formulas to reduce Trotter error (MPF)
Operator backpropagation (OBP) for estimation of expectation (OBP)
Circuit cutting for periodic boundary conditions (CKT)
Wire cutting for expectation values estimation (CKT)
Sample- based Krylov quantum diagonalization of fermionic lattice model (SQD)
Sample-based quantum diagonalization of a chemistry Hamiltonian (SQD)
Low overhead circuit cutting with operator backpropagation (OBP+CKT)
Generating efficient workflows for operator backpropagation (OBP) in a quantum -centric supercomputing (QCSC) software stack (OBP)
Train Students & Faculty Toward Quantum Advantage Algorithms and Use Cases for Quantum-Centric Supercomputing
IBM Quantum Learning –Learn the basics of quantum computing and how to solve real-world problems with IBM Quantum services and systems

1. 20+ quantum courses
2. 30+ hands-on tutorials
3. 10+ curated learning paths and more educational resources by leading quantum experts, Including **John Watrous and Olivia Lanes**

Business courses -Motivate and facilitate Students to Learn about quantum computing essentials and applications for business. Quantum business foundations.

1. Quantum technology fundamentals
2. Use cases and business impact
3. How to become quantum ready

Practical introduction to quantum-safe cryptography

1. Cryptographic hash functions
2. Symmetric and asymmetric keys
3. Quantum-safe cryptography

Make students IBM Certified Quantum Computation enthusiast using Qiskit v2.X Developer

An IBM certified quantum computational enthusiast is an individual who possesses a fundamental knowledge of quantum computing concepts and is able to demonstrate this using the Qiskit SDK as well as Qiskit Runtime. They have experience using the Qiskit SDK from the Python programming language to create and execute quantum computing programs on IBM Quantum computers.

IBM Certified Quantum Computation using Qiskit v2.X Developer - Associate
A Guide to Quantum Computing with Python - You Tube
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