# किरIITH

*the crowning glory*

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భారతీయ సాంకేతిక విజ్ఞాన సంస్థ హైదరాబాద్
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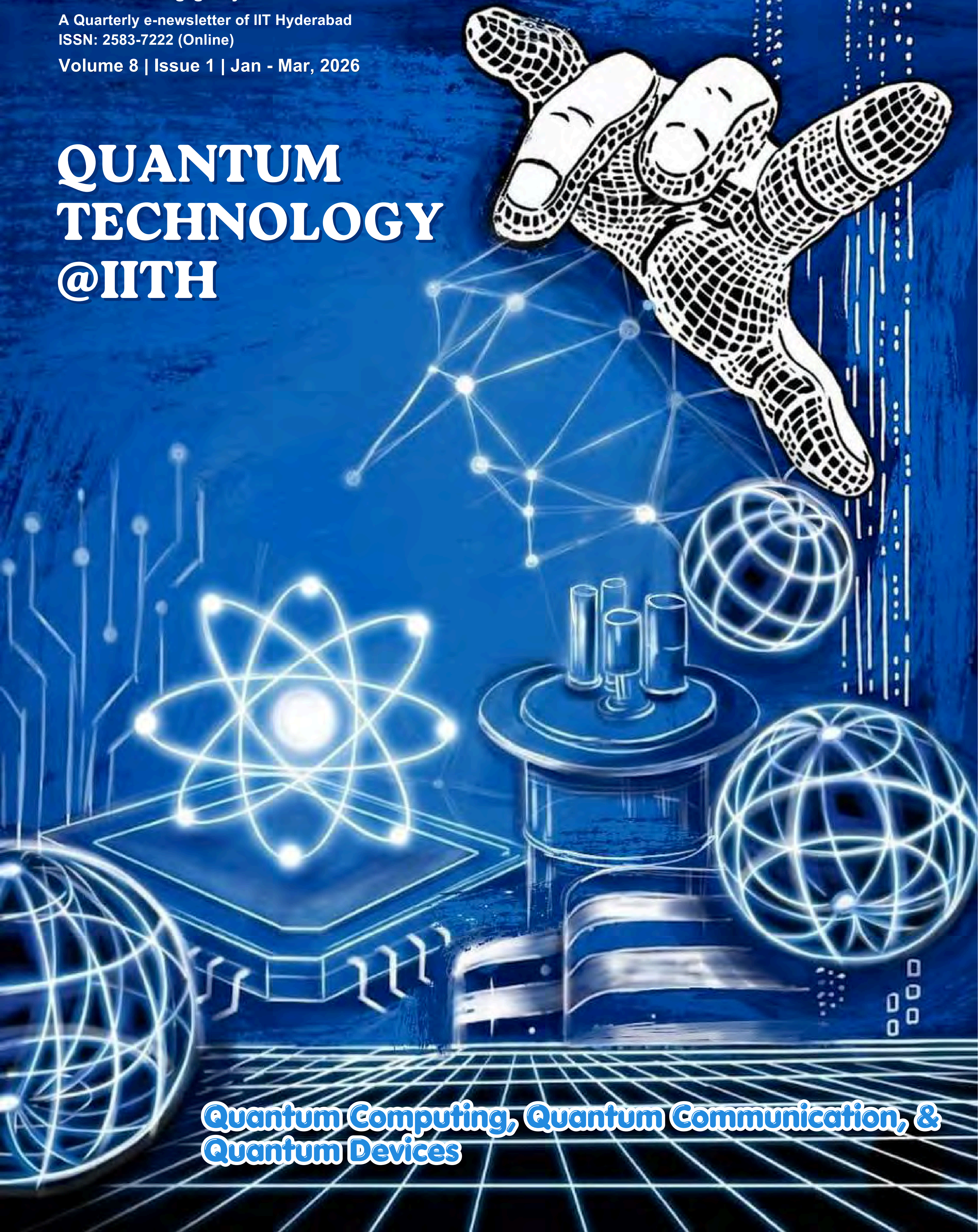
Indian Institute of Technology Hyderabad

# QUANTUM TECHNOLOGY @IITH



## Quantum Computing, Quantum Communication, & Quantum Devices

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# EDITORIAL EPISTLE

Dear Esteemed Readers,
Greetings!!

It is with great enthusiasm that we present Issue 26 of **किरIITH**, themed **"Quantum Technology @ IIT Hyderabad"**—a reflection of our institute's growing contributions to one of the most promising frontiers of science and technology.

As the world enters a new era of innovation, quantum technologies are emerging as powerful enablers of next-generation computing, secure communication, advanced sensing, and intelligent systems. Previously perceived as the territory of theoretical physics, Quantum science is swiftly emerging as a multidisciplinary frontier, poised to reshape industries and redefine society.

Researchers at IIT Hyderabad (IITH) are vigorously pursuing quantum technology, fostering cross-disciplinary partnerships across physics, computer science, electrical engineering, materials science, and allied domains. These efforts are helping to advance both the fundamental understanding and practical applications of quantum systems.

This edition highlights the breadth of quantum research and its emerging applications, spanning quantum computing, communication, devices, machine learning, neuromorphic architectures, memory systems, cryptography, and error correction. The articles featured in this issue highlight how quantum technologies can address complex challenges in areas such as mobility, cybersecurity, artificial intelligence, materials discovery, data storage and information processing.

With India deepening its commitment to quantum technologies via national programs and strategic investments, IIT Hyderabad continues to play a pivotal role in shaping this dynamic ecosystem through cutting-edge research, innovation, and talent development. Through the collective efforts of our faculty, researchers, students, and collaborators, we continue to push the boundaries of knowledge and innovation in this transformative domain.

We gratefully acknowledge the continued support and engagement of our readers, contributors, and well-wishers who make किर*IITH* a meaningful platform to share the institute's journey. We invite you to explore this issue and discover how IIT Hyderabad is contributing to the quantum future.

Access all previous issues of किरIITH at: *https://pr.iith.ac.in/newsletter/about.html*.

Read, reflect, and join us in shaping a sustainable tomorrow!

Warm regards,
The Editorial Team
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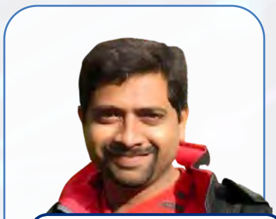

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Dear Friends,

As we present Volume 8, Issue 1 of our newsletter **किरIITH**, themed **"Quantum Technology @IITH –** *Quantum Computing, Quantum Communication & Quantum Devices,*" I am delighted to share some of the significant milestones and achievements that continue to strengthen IIT Hyderabad's position as a leading institution for innovation, research, and technology-driven societal impact. As this issue focused, IIT Hyderabad is actively contributing to the national and global quantum ecosystem through cutting-edge research, interdisciplinary collaborations, and talent development.

The year commenced with Innovation Day 2026, highlighted by the first-ever **Inter-IIT Undergraduate Innovation Meet (RISE 2026)** IITH organized, bringing together UG students from IITs across the country, the event celebrated the spirit of creativity, problem-solving, and entrepreneurship, reaffirming our belief that innovation should begin from the very first year of undergraduate education.

Our research ecosystem continued to expand through new centres, strategic collaborations, and programmes in emerging technologies. The inauguration of the Integrated Lung Health (ILH) Centre, the CODE Studio, and new executive programmes in Artificial Intelligence and Machine Learning strengthened our commitment to cutting-edge research and industry-relevant education. During the India AI Summit, IITH Organized "Conclave on Inclusion for Social Empowerment" in collaboration with the Ministry of Electronics and Information Technology, where we explored how technology can create more inclusive and equitable solutions for society.

IIT Hyderabad also continued to strengthen its engagement with society. Through the launch of **Visit IITH** Portal, we welcomed school students, educators, families, and technology enthusiasts to experience our campus, research facilities, and innovation ecosystem through guided visits. The enthusiastic response to this initiative, along with our first **Annual Book Fair**, reflects our commitment to making knowledge, science, and innovation more accessible to the community.

Our pursuit of excellence has also been recognised globally. IIT Hyderabad recorded a significant rise in the **QS World University Rankings by Subject**, entering the **Global Top 400** in Engineering & Technology, with several disciplines improving their international standing. These achievements reflect the dedication of our faculty, researchers, students, & staff in advancing impactful research with global relevance.

Beyond academics, our campus remained vibrant with **ELAN & nVision 2026**, bringing together technology, culture, creativity, and entrepreneurship. Through **Fit India's Sundays on Cycle** initiative, we further strengthened our commitment to health, sustainability, and active living, encouraging the entire community to embrace environmentally responsible lifestyles.

This quarter also marked the launch of the **IITH Podcast** Series, creating a platform for engaging conversations with leading scientists, innovators, entrepreneurs, and policymakers. Such initiatives strengthen the dialogue between academia, industry, and society while inspiring future generations.

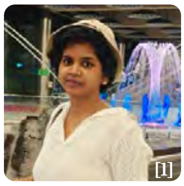
IIT Hyderabad also continues to strengthen its engagement with industry and global partners. Strategic collaborations with organizations such as **Mitsubishi Electric**, and initiatives in critical minerals, sustainable industrial technologies, and advanced manufacturing, are creating new opportunities for research, innovation, and skill development. Through our **Technology Research Park** and innovation ecosystem, we remain committed to bridging academia and industry while accelerating the translation of research into real-world applications.

These accomplishments are the collective efforts of our faculty, students, staff, alumni, and collaborators. Together, we continue to build an institution that not only advances knowledge but also nurtures innovators, entrepreneurs, and leaders capable of addressing humanity's greatest challenges.

I hope you enjoy this edition of किरIITH.

**Prof B S Murty**
**Director, IIT Hyderabad**

# Beyond AI: Could Quantum Technology Drive the Next Automotive Revolution?



KID: 20260101 | Ms Deepika Valurouthu

The automotive industry has transformed dramatically over the last decade through connectivity, electrification, and artificial intelligence (AI). Today, another technology is attracting and growing attention from researchers, governments, and industries worldwide i.e. quantum technology. Although still in its early stages, quantum computing, quantum sensing, and quantum-safe cybersecurity are already being explored for applications such as traffic optimization, battery development, advanced materials research, manufacturing, and autonomous mobility. This article reflects on why the automotive sector is investing in quantum technologies, highlights some of the most promising research directions, and discusses the skills that engineers and researchers can develop today to contribute to this emerging field.

**Looking Beyond AI**

Over the last decade, I have had the opportunity to work in the automotive industry, primarily with Tier-1 suppliers, while also pursuing research at Indian Institute of Technology Hyderabad (IITH). During this period, I have witnessed an extraordinary transformation in vehicles and mobility systems.

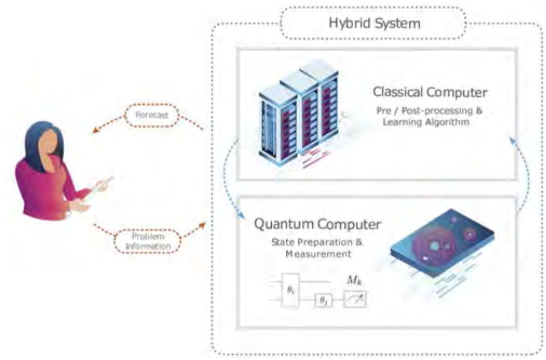
When I started my career, many discussions focused on Electronic Control Units (ECUs), Controller Area Network (CAN) communication, and embedded software. Today, the conversation has shifted toward software-defined vehicles, connected mobility, autonomous driving, cloud platforms, and AI-enabled systems. Modern vehicles are no longer simply transportation machines. They have evolved into intelligent systems—like a moving computer or a digital companion—capable of sensing their environment, processing large amounts of data, and communicating with infrastructure.

Watching this transformation led me to a simple question: If AI is reshaping today's automotive industry, what technology might shape the next generation of mobility? While exploring this question, I repeatedly encountered discussions about quantum technology. Initially, it appeared to be a topic confined to physics laboratories and academic research. However, I soon realized that several automotive manufacturers, Original Equipment Manufacturers (OEMs), suppliers, and technology companies were already investing in quantum-related research. This raised an even more interesting question: What problems in automotive engineering could quantum technology help solve?

**Why Is the Automotive Industry Interested in Quantum Technology?**

The automotive industry faces increasingly complex challenges. Cities struggle with traffic congestion. Electric Vehicle (EV) manufacturers seek better battery technologies. Autonomous vehicles generate enormous volumes of sensor data.Global supply chains must coordinate thousands of components and suppliers. Connected vehicles require stronger cybersecurity protections.

Many of these challenges involve optimization and simulation problems with an enormous number of possible combinations. Traditional computing has enabled remarkable progress, but some problems remain difficult to solve efficiently as their complexity increases. Quantum technologies offer a different approach. Instead of simply performing calculations faster, they use quantum states to solve specific classes of optimization, simulation, and sensing problems in new ways. Although practical quantum systems are still evolving, researchers are already investigating where they might create value.




*(Image Credit: 2019, Cornell University, Arxiv, Page 2, https://arxiv.org/pdf/1906.07682)*

**Rethinking Traffic and Mobility**

Anyone who has spent time in traffic has probably wondered why congestion remains such a persistent problem. Navigation systems can identify routes for individual vehicles, but optimizing traffic flow across an entire city is a far more complex challenge.Millions of vehicles, intersections, traffic signals, and changing road conditions interact continuously.

Researchers are exploring whether quantum optimization algorithms can improve traffic management, fleet operations, ride-sharing services, emergency vehicle routing, and smart city transportation systems. Several pilot studies have already demonstrated traffic optimization using quantum computing techniques. While these studies remain small compared to real-world deployment, they highlight how future mobility systems could become more adaptive and efficient. Imagine a transportation network that continuously predicts and optimizes traffic conditions rather than simply reacting to congestion after it occurs.

**Can Quantum Technology Help Build Better Batteries?**

One of the biggest challenges facing electric vehicles is battery performance. Consumers want longer driving range, faster charging, lower costs, and improved battery life. Achieving these goals requires discovering new materials and understanding complex chemical interactions within batteries. This is where quantum computing has attracted significant attention.

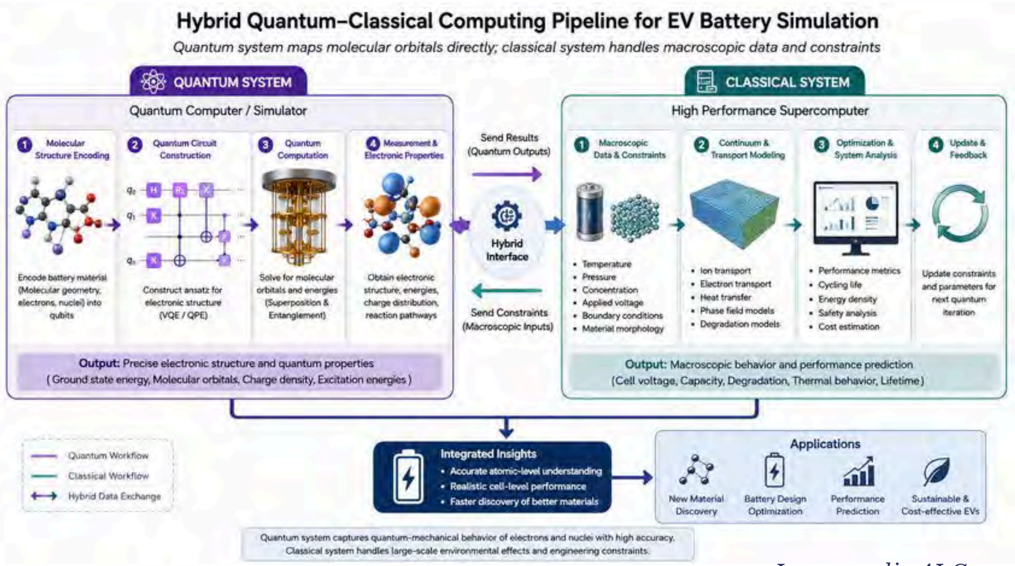



*Image credit:AI Generated*

**Discovering the Materials of Tomorrow**

Material innovation has always been central to automotive progress. Lighter materials improve energy efficiency. Stronger materials enhance safety. Sustainable materials support environmental goals.

Traditionally, discovering new materials requires years of experimentation and testing. Researchers are now exploring whether quantum simulations can help evaluate material behavior before physical prototypes are created. This raises an exciting possibility: Could future engineers test thousands of material combinations virtually before entering the laboratory? Although this vision remains under active research, it represents one of the most promising applications of quantum computing.

**Smarter Manufacturing and Supply Chains**

Quantum technology is not only about improving vehicles. Modern automotive manufacturing is one of the world's most complex industrial ecosystems. Every day, companies must coordinate suppliers, factories, logistics providers, inventory systems, and production schedules. Even small inefficiencies can have significant economic impacts.

Researchers are investigating whether quantum optimization can improve production scheduling, supply chain management, inventory planning, resource allocation, and factory operations.Some experts believe these industrial optimization challenges may become among the earliest commercially viable applications of quantum computing.

Battery behavior originates from interactions between atoms and molecules. Because these interactions themselves follow quantum mechanical principles, they are often difficult to simulate accurately using classical computers. Researchers believe future quantum computers could accelerate the search for advanced battery materials, helping reduce development cycles and enabling breakthroughs in energy storage technologies. If successful, such advances could influence the future of electric mobility more significantly than any single vehicle feature.

**The Quiet Revolution: Quantum Sensors**

When people hear the term quantum technology, they often think only about quantum computers. However, quantum sensing may reach automotive applications sooner. Future quantum sensors could potentially provide extremely accurate positioning, enhanced navigation, improved localization in Global Positioning System (GPS) denied environments, and better environmental perception. For autonomous vehicles, such capabilities could be particularly valuable.

Imagine a vehicle navigating accurately through tunnels, underground parking facilities, or dense urban environments where GPS signals are unreliable. Researchers worldwide are actively exploring whether quantum sensors can make this possible.

**Preparing for the Quantum Era**

One misconception is that quantum technology is relevant only to physicists. In reality, future progress will require collaboration across multiple disciplines. The automotive industry will need professionals who understand both mobility challenges and emerging quantum capabilities.

During my own exploration, I took part in the IBM Quantum Summer Camp and the global Womanium training program. These initiatives provide incredible entry points for beginners, offering hands-on coding modules utilizing Python-based open-source frameworks like IBM's Qiskit and Xanadu's PennyLane.

However, my hands-on experience taught me that simply learning the software syntax is not enough to become a master. We cannot become experts overnight through short training sessions alone. True contribution requires a rigorous willingness to read up on the actual underlying physics—such as understanding how concepts like superposition, entanglement, and interference alter algorithmic logic. The bright side lies in the hardware domain. As quantum hardware becomes more stable, predictable, and accessible through Cloud platforms, the focus will shift to practical application design.

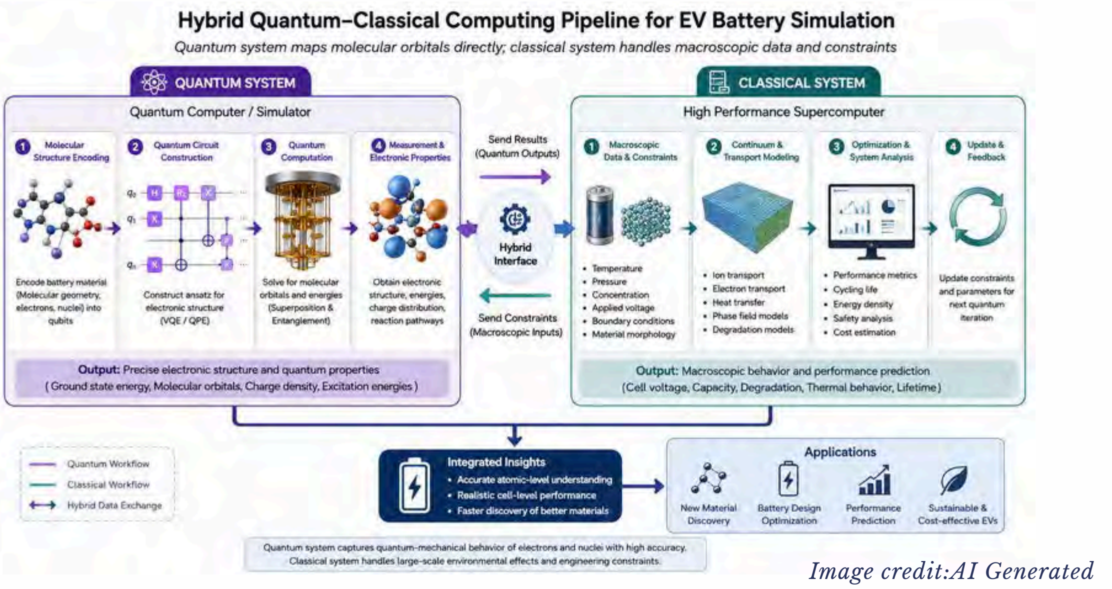



*Image credit:AI Generated*

For students and engineers interested in this area, several skills are likely to become increasingly valuable:

**Automotive Fundamentals**
A strong understanding of vehicle architectures, autonomous driving systems, Automotive Ethernet, Vehicle-to-Everything (V2X) communication, and electric vehicle technologies will remain essential.

**Software and Data Skills**
Many quantum platforms are currently software-driven. Skills in Python programming, data analytics, optimization techniques, Artificial Intelligence, and machine learning provide a strong foundation.

**Quantum Awareness**
Engineers do not need to become quantum physicists immediately. However, understanding concepts such as quantum algorithms, quantum sensing, post-quantum cryptography, and the fundamentals of quantum computing can help identify future opportunities and applications. The goal is not immediate expertise. The goal is awareness and readiness.

**Opportunities for Future Research**
Perhaps the most exciting aspect of quantum technology is that many automotive applications remain unexplored. Researchers can ask questions such as:

- Can quantum optimization improve city-scale traffic management?
- Can quantum simulations accelerate battery innovation?
- Can quantum sensing improve autonomous vehicle localization?
- Can quantum-enhanced machine learning support safer mobility systems?

These questions represent opportunities not only for quantum researchers but also for automotive engineers, communication specialists, materials scientists, and computer scientists.

**Looking Ahead**
The automotive industry has continuously reinvented itself—from mechanical systems to electronics, connectivity, electrification, and artificial intelligence. Quantum technology may represent the next chapter in this evolution.

Significant challenges remain before large-scale deployment becomes reality. Quantum hardware must become more stable, scalable, and accessible. Many practical applications still need validation. Nevertheless, research activity, industrial investment, and global interest continue to grow.

Whether quantum technology transforms mobility as dramatically as AI remains uncertain. However, one thing is already clear: this is no longer a topic reserved for physicists alone. For researchers, students, and industry professionals, the opportunity lies in understanding both the challenges of mobility and the possibilities offered by quantum science. The field is still young, and many automotive use cases remain undiscovered. The next breakthrough may come from someone who can bridge these two worlds.

> “*The core themes, professional experiences, and outline of this article were authored entirely by the candidate based on original industry tracking and research exploration. Generative AI tools were utilized strictly for grammatical polishing, line editing, and adjusting the text structure to comply with the feature-article formatting guidelines of the KirIITH newsletter.*”

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# Bridging Two Worlds: When Machine Learning Meets Quantum Technology


## KID: 20260102 | Dr Sangkha Borah

Quantum technology promises new ways to simulate matter, optimize complex systems, and secure communication. Yet the same quantum effects that make these devices powerful also make them fragile: stray heat, electromagnetic interference, and imperfect control pulses can all corrupt a computation before it finishes. This is where machine learning has become unusually valuable. By learning patterns from large experimental datasets, modern AI systems can help identify noise sources, calibrate hardware, tune quantum circuits, and extract useful answers from imperfect devices. This article introduces the central ideas behind that partnership and explains how machine learning is accelerating progress in quantum control, error mitigation, algorithm design, and emerging neuromorphic hardware. Rather than replacing quantum physics, AI is becoming a practical companion to it - a flexible layer of intelligence that helps translate delicate quantum behavior into reliable technology.

To really grasp why machine learning is so important in quantum tech, let us start by looking at the difference between classical and quantum information. Classical computers use bits to store and process information, following the familiar rules of classical physics. A bit is clear-cut it is either 0 or 1 at any given moment. All the spreadsheets, simulations, and photos you see on regular computers are basically made up of lots of these simple binary choices.

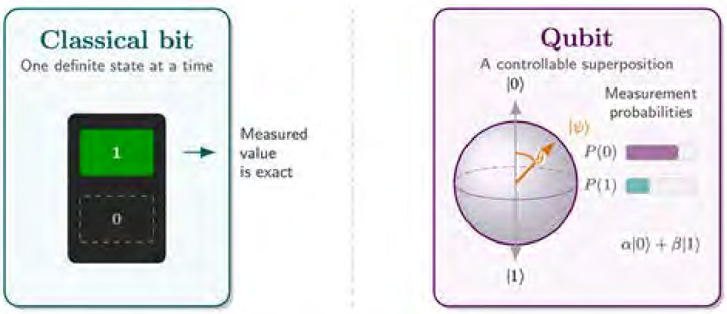


*Figure 1. Classical and quantum information. A classical bit occupiesone definite state, while a qubit is represented by a state vector on the Bloch sphere and yields probabilistic outcomes when measured.That extra structure is the source of quantum computing's power—and its control challenges.*

Quantum computers use qubits, which follow the strange rules of quantum mechanics. Think of a classical bit like a light switch that's either on or off. A qubit, on the other hand, is like a spinning coin. While the coin spins, it is not just heads or tails; it is somewhere in between, a mix of both. This is called superposition, and it means a qubit can hold more information than a single classical bit. Qubits also have another cool quantum trick up their sleeves: entanglement! When two qubits get entangled, what happens to one instantly affects the other, no matter how far apart they are. This kind of connection goes beyond what we can understand with regular, everyday things. Because of superposition and entanglement, quantum


*Figure 2. A hybrid quantum–ML ecosystem. Machine learning contributes at multiple layers of the stack: it helps control hardware, mitigate noise, optimizealgorithms, infer quantum states, explore materials, and inspire new computing architectures.*

**some problems way faster than regular computers.**

That promise does come with a big caveat. Qubits are super sensitive to their environment. Things like tiny temperature changes, unwanted electromagnetic fields, tiny flaws in how they are made, noise from electric charges, and even cosmic rays can mess with their quantum state. This loss of delicate quantum coherence is called decoherence, and it is a major hurdle in making practical quantum computers.

So, to create useful quantum machines, we need not only better equipment, but also smarter ways to sense, understand, and fix mistakes. That is where machine learning comes in! Today's quantum experiments generate tons of data - think repeated measurements, calibration data, pulse responses, tomography results, and device drift histories. These data points hold patterns that can show how a processor acts day to day and pinpoint where its most harmful errors occur.

While our instincts are still super important, the sheer volume and complexity of the data are making algorithms a valuable help. Machine learning is a fantastic fit for this kind of problem. Neural networks, kernel methods, and probabilistic models are built to find patterns in messy, complex data. These techniques are already used in areas like speech recognition, image analysis, finance, biology, and climate science to spot tiny clues. Quantum hardware is a new frontier, but it offers a similar chance: what seems like random noise to us might still have hidden, learnable patterns. This collaboration feels like a natural fit, not something we would have expected. Physicists share their models of the device and the rules of quantum mechanics, while computer scientists bring their algorithms that can spot patterns, guess what might happen, and tweak control plans based on what they see. It is not just about mixing things up for fun; it is a real team effort to make quantum hardware work better, faster, and more effectively.

AI is making waves in quantum tech, especially when it comes to handling errors. We are still striving for completely fault-tolerant quantum error correction, but today's NISQ devices require practical solutions immediately. That requires quantum error mitigation. Error mitigation is not about eliminating all the noise; it is about figuring out what the ideal outcome would have been using the noisy data we have. Think of it like active noise cancellation in headphones. The unwanted sound isn't stopped from existing; instead, the device learns enough about the disturbance to reduce its impact on what the listener hears. In the quantum world, a model can be trained on lots of examples of noisy measurements and trusted reference results. Over time, it learns the unique "fingerprint" of a device's errors and can predict a corrected answer from imperfect observations. These methods are especially helpful because they can make the most of our current hardware without needing the massive qubit resources that full-scale error correction would require. Machine learning can help clean up the readout signals, figure out what's expected, sort out error patterns, and adjust for slowly changing hardware. The best methods often mix things up: they use our understanding of the device with a data-driven model that learns and changes as the system evolves.

Quantum computation is not just about storing information; it is also about controlling it with amazing accuracy. For instance, in superconducting processors, qubits are moved around using carefully crafted microwave pulses. Similarly, in trapped-ion setups, laser pulses need to be finely tuned. Even tiny changes in timing, strength, or phase can lead to the wrong quantum gate or slow down the computation. Machine learning has become a fantastic tool for solving this control challenge. Reinforcement learning, Bayesian optimization, and surrogate modeling can explore huge parameter spaces much faster than just manually adjusting everything. Instead of tweaking every pulse sequence by hand, researchers can let an optimization agent suggest controls, see how they work, and keep getting better. This is important not just for the hardware, but also for how we write the algorithms. Many quantum algorithms that are close to being ready, like the Variational Quantum Eigensolver (VQE) and the Quantum Approximate Optimization Algorithm (QAOA), rely on adjusting lots of free parameters. AI-powered optimizers can help make the circuits shorter, pick better starting points, and guide the search toward useful solutions before the computer gets too tangled up with decoherence.

It is not just AI helping quantum tech; quantum physics might also change how AI works! This is especially true in neuromorphic and physical learning systems, where the hardware is built so that its own movements play a direct role in computing and adapting. Neuromorphic computing draws from the brain, focusing on distributed processing, memory-computation teaming up, and energy-efficient movements, instead of sticking to strict, clock-driven logic. Quantum materials and strongly correlated systems offer a fascinating way to expand on that idea. Since they naturally support complex group behavior, they might create physical platforms where learning is not just a software trick, but a part of how the material responds. This idea is still being explored, but it is important. If it works, these devices could give us new ways to handle complex data, understand intricate physical systems, or make training advanced AI models more energy efficient. Even if the hardware is not fully quantum, the main takeaway is that the line between "computer" and "physical system" is blurring, which means we have more room to design future smart machines.

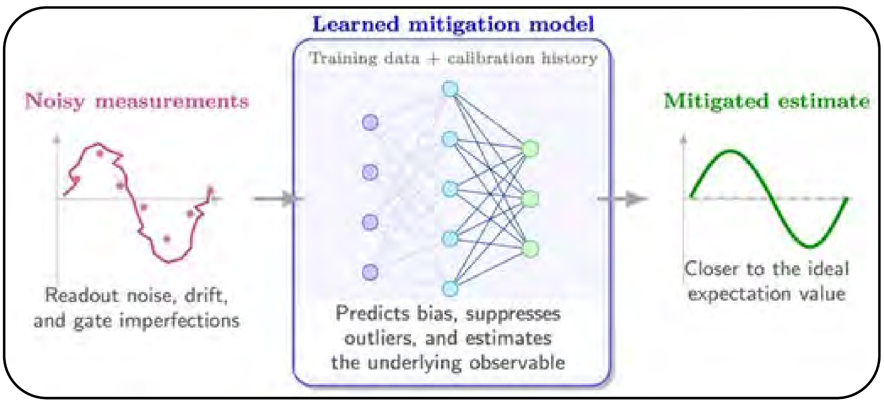


*Figure 3. Deep learning for error mitigation. A model is trainedon repeated devicebehavior so that noisy measurement records can be mapped to a more faithful estimate of the underlying quantum observable. This does not replace full error correction, but it can substantially improve near-term experiments*

Quantum technology today is like the early days of classical computing: it is full of potential, but it is still limited by what we can build, and it is getting better all the time because of better engineering. We are not quite there with noisy intermediate-scale devices yet, but they are already pretty useful tools for science. The big question is how fast we can go from these cool experiments to solid, scalable systems. Machine learning is helping us bridge that gap. It connects the stable world of classical data processing with the super sensitive nature of quantum hardware. By learning from calibration data, improving controls, finding clearer measurements, and speeding up design, AI makes our imperfect quantum devices more useful now and helps us design even better ones for the future.

The long-term future will still depend on advances in materials, making things, designing systems, and eventually fixing errors. But what we're seeing right now is that progress in quantum technology is no longer just about physics. It's also about being able to understand complex data and make quick, smart decisions. So, machine learning isn't just something we add to the quantum world; it's becoming a key part of how we make it happen.

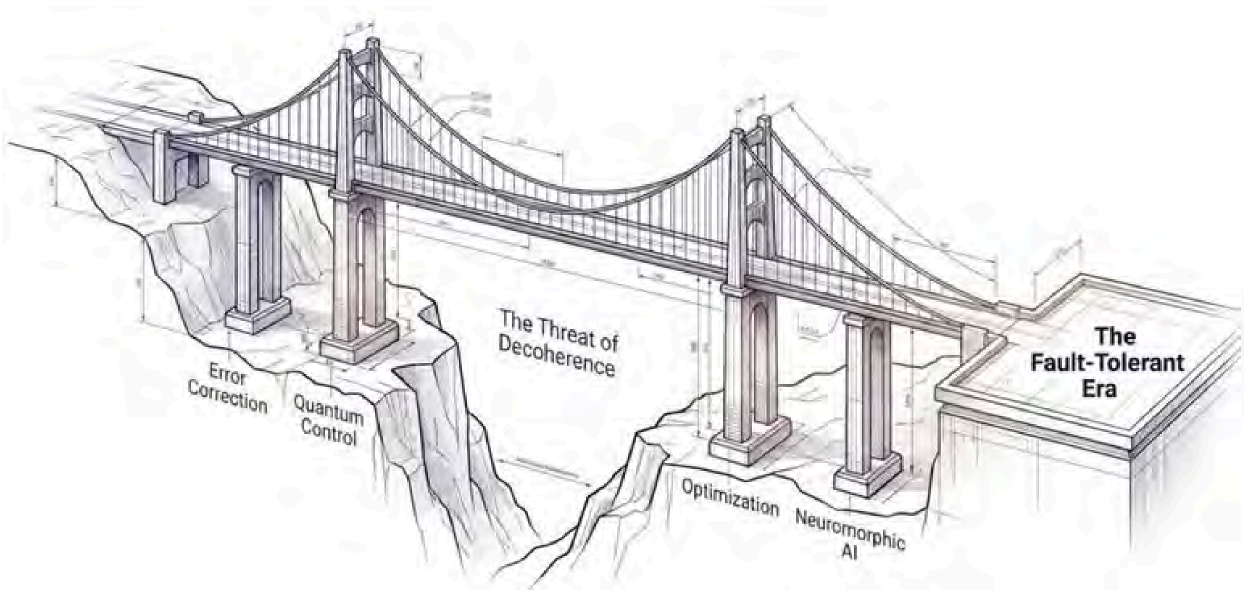


*Figure 4: Machine Learning as a bridge between NISQ era to Fault-tolerant Quantum Era. This figure was generated by NotebookLM (Apr. 22, 2026)*

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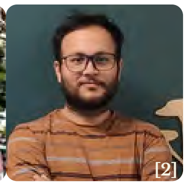
# Brains, Qubits, and the Next Frontier of AI: The Rise of Quantum Neuromorphic Computing

KID: 20260103 | Mr Subodh Roushan , Dr Sangkha Borah

As artificial intelligence reshapes society, it faces an unsustainable energy bottleneck: modern deep learning models require megawatts of power to train. To build sustainable intelligence, researchers are looking to physics—merging brain-inspired neuromorphic engineering with quantum mechanics. Quantum Neuromorphic Computing implements neural structures directly in quantum hardware, exploiting superposition and entanglement to process information. Crucially, QNC can embrace the noise of near-term quantum processors as a learning asset, bypassing expensive error-correction bottlenecks. This article explores how this emerging paradigm is redefining computation, from physical learning algorithms to device fabrication at the Indian Institute of Technology Hyderabad.

While modern artificial intelligence (AI) performs complex tasks in seconds, digital silicon computers run these algorithms with immense inefficiency. Training a state-of-the-art natural language model consumes hundreds of megawatt-hours of electricity, enough to power a household for years.

This inefficiency is rooted in the traditional von Neumann architecture, which physically separates processing and memory. Continuously shuttling data between CPU and memory chips consumes the vast majority of a computer's energy during deep learning tasks. Conversely, the human brain operates on just twenty watts of power.

It achieves this by co-localizing processor and memory functions in a dense, interconnected network of neurons and synapses. Computation is performed in-place, driven by the natural physics of neural tissue.

To mimic this efficiency, researchers are building physical neural networks (PNNs). As highlighted in a recent review in Nature (Momeni et al., 2025), these systems perform computations by mapping neural operations directly onto hardware physics. As illustrated in Figure 1, PNNs can be categorized into two paradigms: isomorphic networks

(which enforce a strict, operation-by-operation mathematical equivalent, such as mem- ristive crossbar arrays performing matrix-vector multiplication) and broken-isomorphism networks (which train the natural, non-linear physical transformations of the hardware directly). By utilizing these natural analog dynamics, PNNs execute AI calculations directly, drastically reducing energy costs.

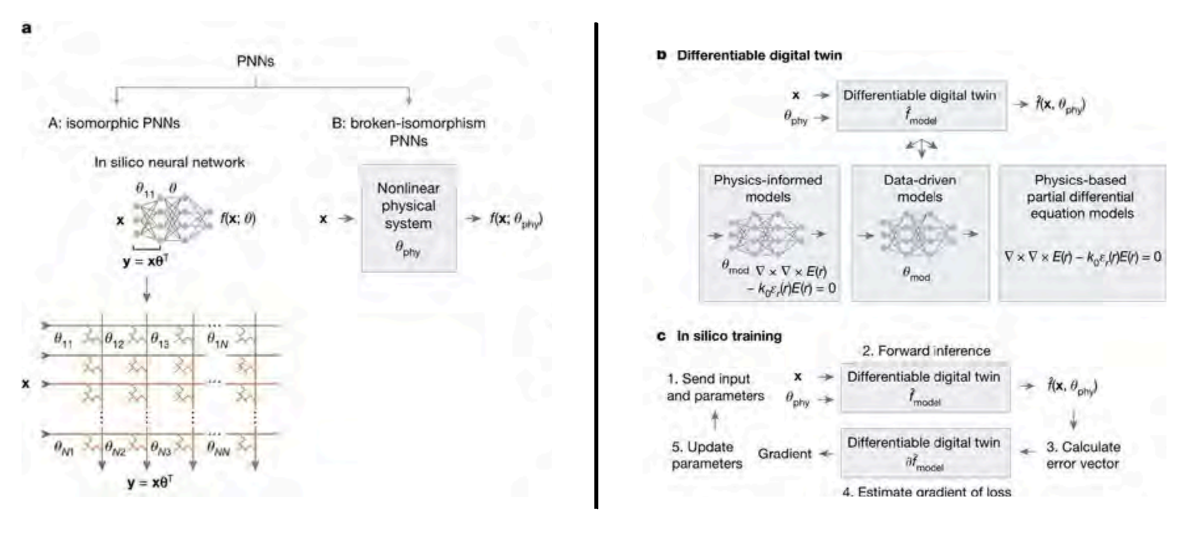



*Figure 1: Isomorphic versus broken-isomorphism physical neural networks. (a) Isomorphic physical neural networks enforce a strict, operation-by-operation mathematical equivalent (such as memristive crossbar arrays performing matrix-vector multiplication).*

*(b) Broken-isomorphism networks train the natural physical transformations of the hard- ware directly (such as optical scattering or wave propagation), making them more flexible but harder to train. (Source: Momeni et al., Nature, 2025)*

### Bridging the Brain and the Qubit

While physical networks offer a path to energy-efficient AI, integrating them with quantum mechanics opens new computational dimensions. Quantum Neuromorphic Computing (QNC) implements brain-inspired neural networks in quantum hardware. As formalized in a seminal perspective by physicists Danijela Marković and Julie Grollier in *Applied Physics Letters* (2020), QNC exploits quantum properties to scale neural networks far beyond classical limits.

The field is split into two major methodologies:

- **Digital Quantum Neural Networks**: These run on gate-based quantum com- puters, utilizing parametrized quantum circuits (PQCs) where adjustable quantum logic gates act as trainable weights.
- **Analog Quantum Neuromorphic Systems**: These leverage the natural analog dynamics of quantum oscillator assemblies. These oscillators made of supercon- ducting Josephson junctions or spintronic elements—physically emulate the oscil-latory behavior of biological neurons and synapses.

By bypassing digital logic, analog quantum networks process information in a highly parallel manner, utilizing physical relaxation dynamics to solve complex pattern-recognition tasks.

Harnessing Quantum Quirks and Noise

Quantum neuromorphic systems utilize two primary quantum phenomena: superposition and entanglement. Superposition allows a quantum node to represent multiple active states simultaneously, exponentially increasing the network's capacity. Entanglement creates strong non-local correlations across the network, enabling parallel information processing that mimics the coordinated firing patterns of the human brain.

Crucially, QNC offers a unique solution to the problem of quantum noise. Today's Noisy Intermediate-Scale Quantum (NISQ) processors are highly sensitive to environmental in- terference. Traditional quantum computing requires massive error-correction overhead to protect fragile qubits from this noise.

In contrast, biological brains are inherently noisy, using chemical and electrical fluctuations to perform stochastic learning. By taking inspiration from the brain, quantum neuromorphic systems can treat quantum noise as a computational asset rather than a liability. Quantum fluctuations can drive stochastic learning, helping the network escape local minima without the massive overhead of digital error correction.

### Behind the Scenes: The Clash of Disciplines

The emergence of QNC was not a straightforward progression, but rather a clash of two distinct scientific cultures. In the late 2010s, quantum physicists were focused on math- ematical precision, trying to build error-corrected qubits for digital algorithms. Neuro- morphic engineers, meanwhile, were building analog chips that accepted noise and device variations as natural design constraints.

When researchers first proposed building a brain out of qubits, the idea met with deep skepticism. Physicists argued that continuous feedback loops and measurements would collapse fragile quantum states, while computer scientists doubted physical hardware could learn without the exact calculations of backpropagation.

To bridge this divide, interdisciplinary teams formed under collaborative frameworks like the European Union's Quromorphic project. A major breakthrough occurred when the- orists demonstrated quantum reservoir computing (Fujii & Nakajima, 2017). By using a disordered, untrained network of quantum oscillators as a "reservoir" to project input data into a high-dimensional quantum space, they showed that only a simple classical output layer needed to be trained. This elegant compromise preserved fragile quantum states while achieving high-performance machine learning, proving that quantum neuro-morphic hardware was experimentally viable.

### The Physical Challenge of Training

To scale QNC from laboratory demonstrations to real-world utility, researchers must solve the physical challenge of training. Standard deep learning relies on backpropagation, an algorithm that calculates weight adjustments by propagating errors backward through the network. However, running backpropagation on analog physical hardware is extremely difficult because it requires storing intermediate states and running physical dynamics backward in time. To train these systems, researchers initially developed Physics-Aware Backpropagation (PABP), as illustrated in Figure 2. In this hybrid scheme, the forward pass is executed

directly on the physical hardware to capture its exact dynamics, while the backward pass runs in-silico using a digital model of the physical system to compute gradients and update weights.

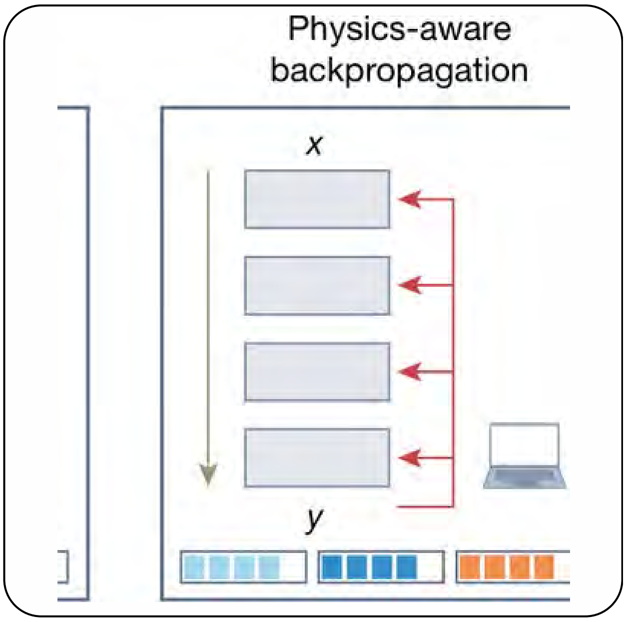



*Figure 2: Physics-aware backpropagation (PABP) for training physical neural networks. The forward pass is executed directly on the physical hardware to obtain the output, while the backward pass runs in-silico using a mathematical model of the physical system to compute gradients and update weights. (Source: Momeni et al., Nature, 2025)*

To achieve fully on-chip learning without relying on digital backups, backpropagation free training algorithms are being actively developed (Figure 3). One promising method is Equilibrium Propagation, where the physical network settles into equilibrium under input data, and output nudges automatically generate local training gradients. Other methods include Hamiltonian Echo Backpropagation (which uses physical time-reversal protocols in quantum systems to approximate the backward pass) and Scattering Backpropagation. These techniques enable physical systems to learn in-situ using their natural dynamics.

### The Horizon of Intelligence

Quantum neuromorphic computing is transitioning from theoretical physics to laboratory prototypes. Significant challenges remain, including scaling the number of coupled oscillators, improving coherence times, and refining physical learning algorithms.
Nonetheless, the potential rewards are immense. By combining the high-dimensional ca- pacity of quantum mechanics with the energy efficiency and noise tolerance of the brain,

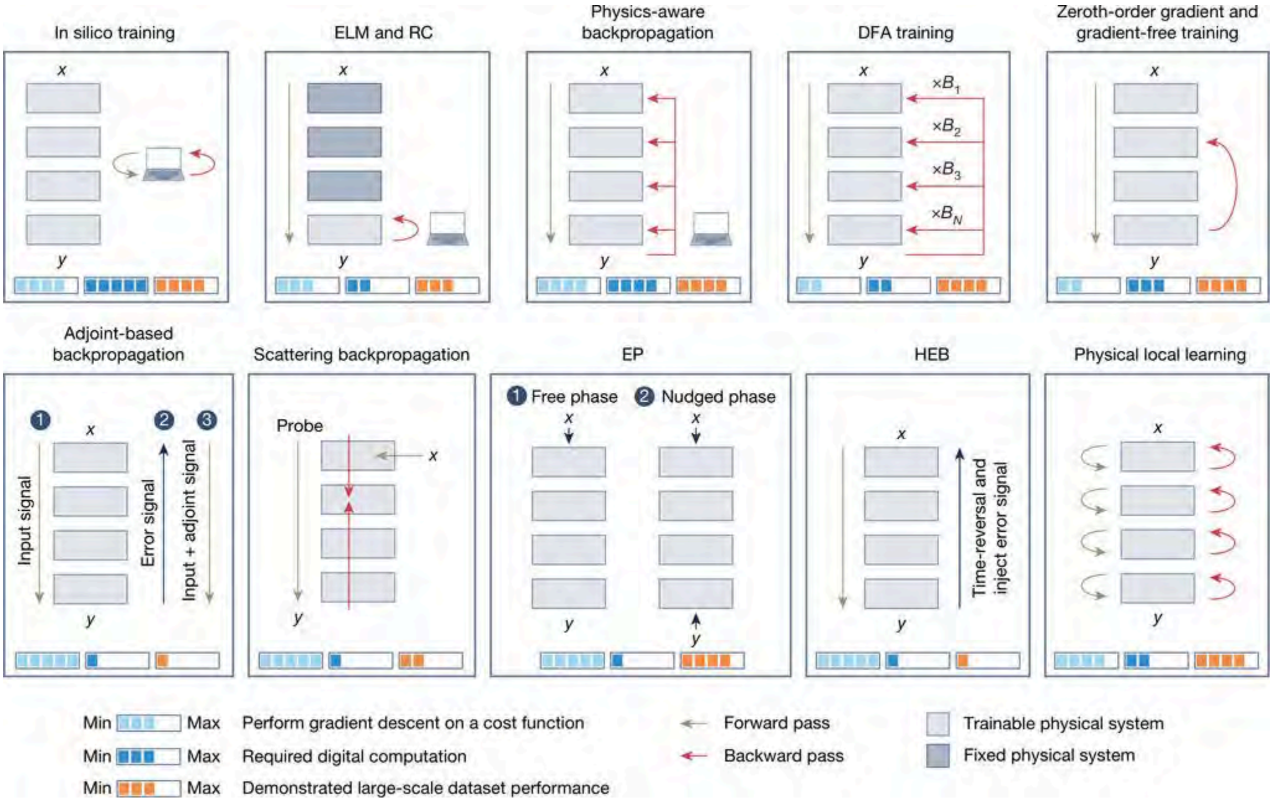



*Figure 3: Comparison of physical training methods. A comparative schematic showing backpropagation based training (which requires numerical or digital model backups) ver- sus backpropagation free methods (like Equilibrium Propagation, Hamiltonian Echo, and Scattering Backpropagation) that run training fully on-chip using local physical interactions. (Source: Momeni et al., Nature, 2025)*

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> *QNC could unlock computational efficiencies that are currently unimaginable. Through collaborative innovations, researchers at IIT Hyderabad and worldwide are laying the physical foundation for a smarter, more sustainable computational future.*


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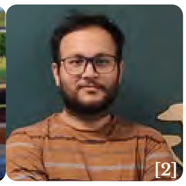
# Learning in the Quantum Space: Algorithms and Optimization in Quantum Machine Learning




KID: 20260104 | Ms Anjana K, Dr Sangkha Borah

*Quantum machine learning (QML) has emerged as a compelling hybrid paradigm at the interface of quantum information science and machine learning. By utilizing parameterized quantum circuits (PQCs) as trainable functional models, QML offers a pathway to perform complex pattern recognition, classification, and chemical simulations on noisy intermediate-scale quantum (NISQ) devices. This article presents a comprehensive exposition of QML algorithms, detailing their mathematical architecture, the closed-loop classical-quantum optimization cycles used to train them, and the critical training hurdles such as the barren plateau phenomenon. Additionally, we discuss quantum kernel methods, which exploit the massive dimensionality of Hilbert spaces to map and classify non-linear classical datasets. Through a combination of quantum state manipulation and classical optimization, QML charts a promising course toward the next generation of artificial intelligence.*

**Introduction: The Intersection of Two Frontiers**

Artificial intelligence and quantum computing represent two of the most powerful technological pillars of our era. Classical machine learning models, while highly successful, face severe physical limits in training speed and energy efficiency when handling high-dimensional data. Quantum computing offers a different path by exploiting quantum superposition and entanglement to represent complex data states. The integration of these fields forms Quantum Machine Learning, where quantum technology acts as a specialized co-processor.

To understand this synergy, it is helpful to look at how we deploy current quantum processors. We are in the Noisy Intermediate-Scale Quantum (NISQ) era, where devices possess tens to hundreds of qubits but lack the resources for full-scale error correction. Running deep, long-duration algorithms is impossible because environmental noise destroys quantum coherence. To utilize NISQ hardware, researchers use a hybrid classical-quantum co-processing architecture. In this setup, the quantum device performs specific, high-dimensional calculations that are hard for classical systems, while a classical computer handles the remaining data processing and optimization. This division of labor allows us to run short, noise-resilient algorithms.

This hybrid structure mirrors the way GPUs are used alongside CPUs in classical deep learning. Just as a CPU delegates heavy matrix multiplications to a GPU, a classical computer in a QML framework delegates the preparation and evaluation of high-dimensional quantum states to the QPU. The QPU exploits its physical Hilbert space to represent state vectors that would be far too large for classical memory, while the classical host handles the control logic and parameter updates. This synergy makes it possible to explore quantum-enhanced machine learning without waiting for full fault-tolerant quantum computers to be built.

Classical simulation of quantum circuits remains a critical tool for developing and verifying these NISQ-era algorithms. However, simulating large, highly entangled quantum systems classically is challenging due to the exponential growth of state spaces. Recently developed algorithms, such as the Basis-Adaptive Sparse-State (BASS) simulation method [1], attempt to mitigate this by dynamically updating the local representation basis of qubits during circuit execution, keeping amplitude distributions highly localized and enabling more efficient verification of QML models.

**The Core Engine: Parameterized Quantum Circuits**

At the heart of variational QML lies the Parameterized Quantum Circuit, which functions as the quantum analogue of a classical neural network. The circuit is structured to execute a mathematical mapping from a classical input space to a quantum state space, and finally to a classical prediction. As illustrated in Figure 1, this process is divided into three sequential stages.

The first stage is State Preparation, or data encoding. Here, classical data is mapped into a quantum state via a feature map U(x). The choice of encoding represents a major design decision.For instance, angle encoding maps each classical feature directly to a single-qubit rotation, maintaining low circuit depth. Conversely, amplitude encoding maps a $2^N$-dimensional vector into the amplitudes of N qubits, achieving exponential data compression at the cost of deep state-preparation circuits that are highly sensitive to noise.

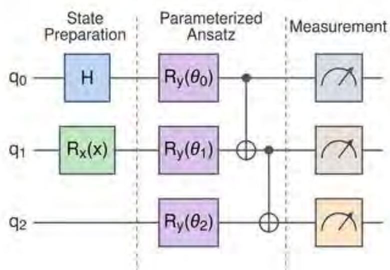



*Figure 1: The typical architecture of a Parameterized Quantum Circuit (PQC). The circuit flow moves from left to right through three main stages: (1) State Preparation U(x), which encodes classical input data x, (2) Parameterized Ansatz V(θ), which features tunable rotation gates and entangling gates, and (3) Measurement/Readout to yield classical data.*

The second stage is the Parameterized Ansatz V(θ), consisting of tunable rotation gates and entangling gates. The rotation gates act as the adjustable weights of our quantum neural network, while entangling operations allow the model to learn complex, non-local correlations across the inputs. Choosing the right ansatz is crucial for the success of a QML model. It must be expressive enough to represent the target function, yet simple enough to be executed on noisy hardware. Finding the balance between expressibility and trainability remains a major challenge in circuit design.

The third stage is Measurement and Readout, where we measure the expectation values of physical observables, obtaining a classical output. This output represents the model's prediction, which can be interpreted as a classification label or a regression value.

**The Hybrid Training Loop and Optimization**

Training a PQC is formulated as a hybrid optimization task, shown in Figure 2. The quantum hardware computes expectation values to evaluate a loss function, which represents the model's error. This loss value is sent to a classical optimizer running on a CPU or GPU. The classical algorithm computes parameter updates to minimize the cost, using optimizers like gradient descent, Adam, or derivative-free methods such as COBYLA [2]. These updated parameters are sent back to adjust the quantum gate angles for the next iteration. This closed loop repeats until convergence.

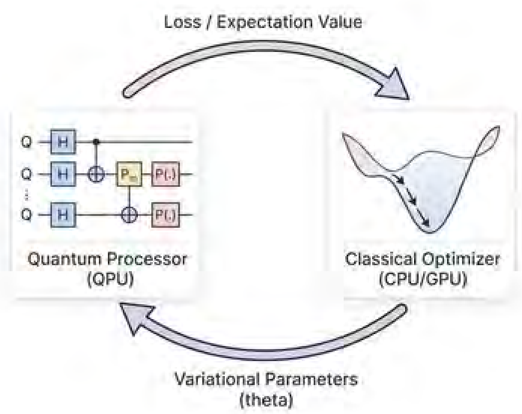



*Figure 2: The hybrid quantum-classical machine learning training loop. The Quantum Processor (QPU) processes input data x and variational parameters θ to measure expectation values. The loss is sent to the Classical Optimizer (CPU/GPU), which runs optimization algorithms and updates the parameters for the next iteration.*

A key challenge is computing gradients on quantum hardware. Since we cannot directly differentiate a physical quantum state, we use the parameter shift rule. This rule calculates the exact gradient of a quantum gate with respect to a parameter by running the quantum circuit twice, with the parameter shifted forward and backward. Subtracting these measurements yields the analytical gradient without classical finite-difference approximations, which are sensitive to experimental noise.

The choice of optimizer is critical on noisy QPUs. Gradient-based optimizers are powerful in simulations, but on real hardware, estimating gradients is expensive and noisy because of measurement shot noise. As a result, derivative-free optimizers such as COBYLA or noise-resilient gradient methods like Simultaneous Perturbation Stochastic Approximation (SPSA) are widely preferred. SPSA estimates the gradient by perturbing all parameters simultaneously in random directions, requiring only two circuit evaluations per step regardless of the parameter count, which drastically reduces the measurements needed on real hardware.

**The Optimization Landscape: Barren Plateaus**

Despite the elegance of the hybrid training loop, optimization in QML faces a severe hurdle: the barren plateau phenomenon [3]. In deep parameterized quantum circuits, the gradients of the cost function vanish exponentially with the number of qubits, creating a flat, featureless cost landscape where the optimization algorithm stalls.

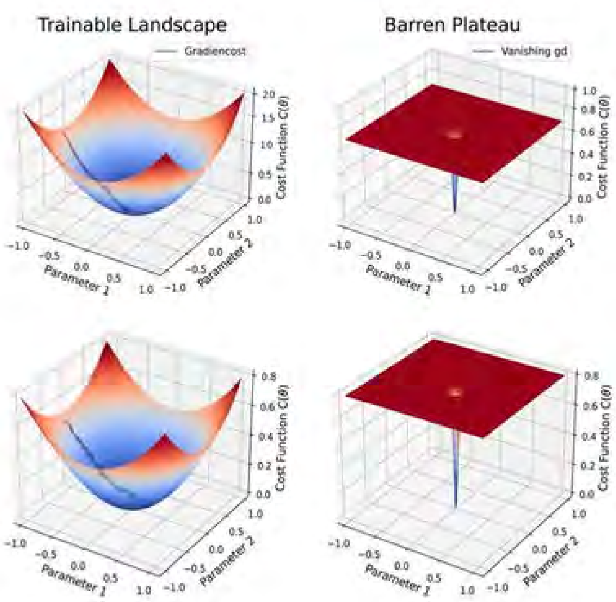



*Figure 3: Comparison of QML optimization landscapes. The Trainable Landscape (left) features steep gradients and a clear path to the global minimum. In contrast, the Barren Plateau (right) shows a flat, featureless plane where gradients vanish, leaving optimization algorithms stalled. The global minimum becomes a needle in a haystack.*

Figure 3 illustrates this contrast. While a trainable landscape has steep gradients leading to a clear global minimum, a barren plateau is flat. Since the gradients are zero, optimization algorithms stall, unable to find the global minimum. Mathematically, this is linked to the concentration of measure on high-dimensional spheres. As the quantum Hilbert space grows exponentially, random initializations of highly entangling ansatzes make the state vectors point in directions where the cost function is almost uniform. Unlike classical neural networks, which can often be initialized randomly, quantum networks require highly structured initialization protocols, local cost functions, or shallow circuits to remain trainable.

To overcome barren plateaus, researchers are developing specialized initialization strategies, using shallow circuit ansatzes, and designing local cost functions (which compare individual qubits rather than the entire system) that exhibit weaker barren plateau effects. Understanding and navigating these landscapes is a major focus of ongoing optimization research.

**Quantum Kernels and High-Dimensional Spaces:** An alternative approach to variational training is quantum kernel machine learning, which exploits the high-dimensional Hilbert space directly [4]. In classical machine learning, Support Vector Machines (SVMs) use kernel methods to map data into a higher-dimensional space where non-linearly separable datasets become linearly separable by a hyperplane.

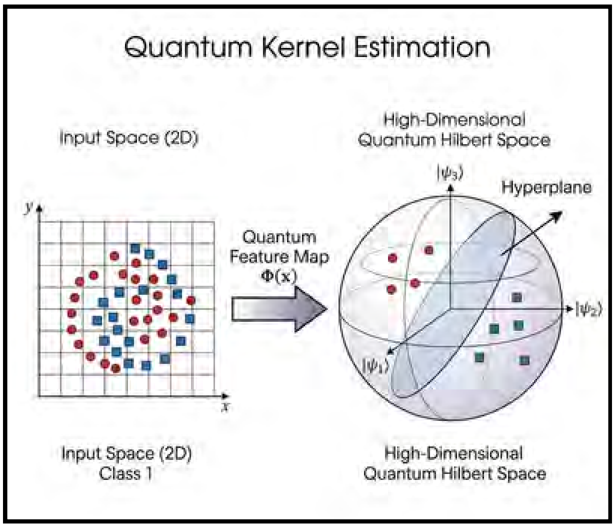



*Figure 4: Quantum kernel estimation. Classical data points in a 2D input space (left) are mapped via a quantum feature map $\Phi(x)$ into a high-dimensional quantum Hilbert space (right). In this higher-dimensional space, the data points become linearly separable by a hyperplane.*

In quantum kernel methods, illustrated in Figure 4, classical data points are mapped onto a high-dimensional quantum state space using a feature map [5]. The quantum computer then computes the inner product between different data states, which represents the quantum kernel matrix. Since calculating these inner products is classically intractable for large systems, the quantum hardware provides a direct computational advantage. The kernel matrix is then processed by a classical SVM to find the separating hyperplane, combining quantum feature mapping with robust classical classification.

This mapping represents a direct physical implementation of the classical "kernel trick." Instead of calculating high-dimensional vectors mathematically on a classical computer, we encode the data onto physical qubits. The quantum state space itself acts as the high-dimensional Hilbert space, and the physical overlap of the quantum wavefunctions computes the kernel values naturally.

If the feature map $\Phi(x)$ is designed to be highly complex, the resulting kernel matrix is impossible for a classical computer to estimate, offering a path to demonstrating a quantum advantage on classical classification tasks.

> *"Outlook and the Path Forward*
> *The fusion of quantum technology and machine learning is still in its infancy, yet it represents one of the most exciting frontiers in computational science. As quantum hardware scales and noise levels decrease, QML algorithms will move from small-scale demonstrations to solving real-world problems. The key to unlocking this potential lies in designing hardware-efficient ansatzes and developing robust optimization techniques that can navigate complex quantum cost landscapes. By continuing to bridge these two fields, researchers are establishing the foundations for the next generation of intelligent computing systems."*

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# Quantum Systems as They Truly Are: Open, Driven, and Out of Equilibrium


KID: 20260105 | Dr Archak Purkayastha

**The Big Picture: What We Are Trying to Understand**

Quantum mechanics is the science of the very small — atoms, electrons, and particles that make up everything around us. It has already shaped much of the present technology. After all, even understanding transistors, the main workhorses of modern technology, is not possible without using some quantum concepts. What then does the new and exponentially growing catch-phrase, "Quantum technology" refer to? One useful and accurate definition for the term "Quantum technology" is "Technology that becomes possible when we have control and measurement at the level of single excitations", think single photons, single electrons etc. This is as opposed to present semiconductor technology, which is based on controlling currents carried by millions of electrons, with no direct control over individual electron flow.

What emerged from decades of often startling theoretical discoveries is that this fine-grained control is not merely a technical curiosity — it unlocks advantages in speed, security, and accuracy for certain tasks that are provably beyond the reach of any device operating on bulk currents and averaged signals. These form the basis for modern quantum computing, quantum communication and quantum sensing.

However, much of the early work have treated quantum systems as though they existed in perfect isolation: sealed off from the world, undisturbed and pristine. This is a beautiful starting point, but it is not reality.

In the real world of quantum technology, quantum systems are always in contact with their surroundings. They absorb energy, lose it, exchange particles, and are constantly nudged and driven by external forces. In formal terms, such systems are called open quantum systems. Think of a vibrating guitar string: you cannot understand its sound if you ignore the air around it, the wood it is attached to, or the musician's fingers driving it.

This is the central challenge: How do we describe, predict, and ultimately control quantum systems that are open, noisy, and continuously driven? The answer matters enormously — it is the key to building reliable quantum computers, designing ultra-precise sensors, and even understanding how energy flows at the smallest scales in nature. In our group, "D2Q: Driven dissipative quantum systems" in the Department of Physics at IIT Hyderabad, we attempt to answer these questions and explore the exotic physics.

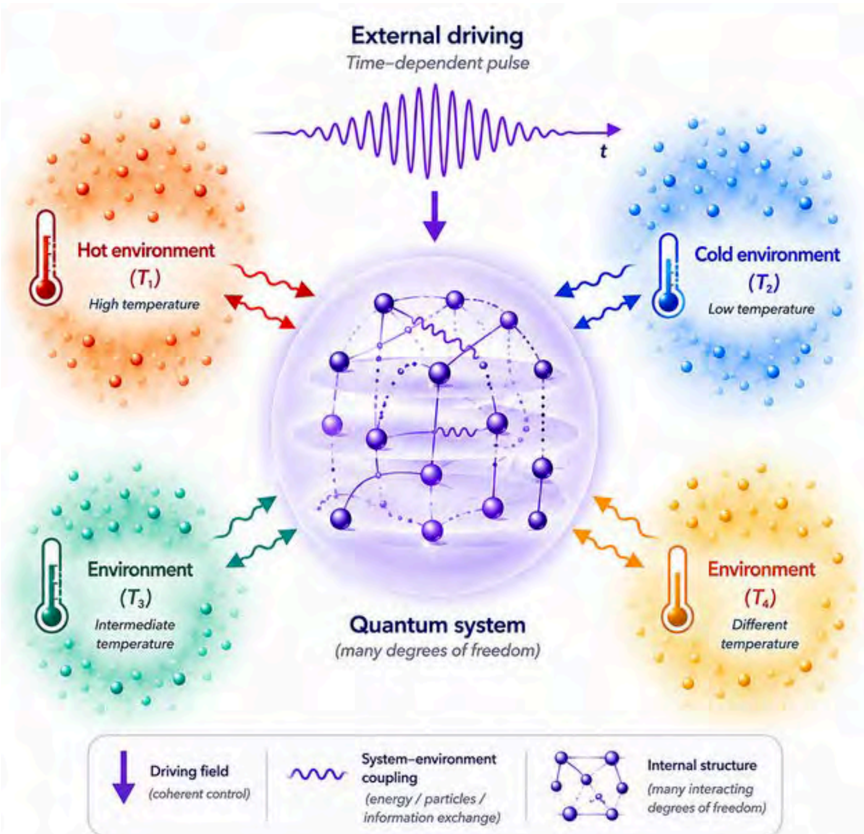


*Figure 1. Real quantum systems are driven, have many internal degrees of freedom and are coupled to multiple environments at different temperatures*

**New Tools for a Messier, More Realistic World**

To describe quantum systems in contact with the surroundings, scientists have long used a set of mathematical rules based on an approximation — known as the Born-Markov approximation — as the standard way to describe how an open quantum system evolves in time. This approximation leads to equations that are elegant and widely used. They work beautifully under certain idealized conditions: when the environment is large and forgetful, when interactions are weak, and when nothing changes too quickly.

But modern quantum hardware often lives outside these comfortable conditions. Quantum processors are driven hard and fast. Their components interact strongly. The environments they sit in have memory — they can remember and feed back information in ways the standard equations simply cannot capture. Under such situations, the standard equations not only give inaccurate answers, but can also lead to violation of conservation laws. And in quantum technology, inaccurate answers can mean the difference between a working device and a broken one. A central strand of our research has been rigorously mapping out exactly where and why the standard description fails [1].

Identifying the problem is only the first step. The deeper goal is building better tools — methods that remain accurate even when quantum systems are driven hard, strongly interacting, or coupled tightly to complicated environments. This has emerged as one of the most important research directions for quantum technology over the last decade, where we have also contributed. We have developed a family of methods that generalizes the standard approach so that it remains valid for systems that are driven in arbitrarily complicated ways — rapidly oscillating fields, sudden switches, complex pulse sequences of the kind used in quantum computing [2-5]. These methods systematically account for the memory effects that the environment carries, and they do so without requiring the interactions to be weak. This makes them applicable to a much broader class of real-world quantum devices.

Many-body quantum systems — those involving many interacting particles — are notoriously hard to simulate because the amount of information needed grows exponentially with the number of particles. Tensor networks are a powerful mathematical compression technique borrowed from computer science. They exploit the fact that quantum systems often have structured, not random, patterns of correlations. By combining the new beyond-standard methods with tensor network tools, it becomes possible to simulate open many-body quantum systems without any assumption that interactions are small [2, 5]. This allows accurate descriptions of quantum dynamics at a level previously out of reach, often uncovering completely new physics [6].

**Error Modelling for Quantum Computing and Communication**

Every real quantum processor is imperfect. Its building blocks — individual quantum bits, or qubits — are perpetually jostled by thermal noise, electromagnetic interference, and crosstalk from neighbouring components. Understanding exactly how and why a specific piece of hardware works or fails requires simulating it as a realistic open system, with all its environmental couplings faithfully included. The new theoretical/numerical frameworks make it possible to model these error processes from first principles, going well beyond the simplified noise models that are typically assumed [7, 8]. The result is a much more accurate picture of how errors arise in practice — which is the essential first step towards suppressing them.

**Quantum Thermodynamics: The Physics of Energy and Information**

How does heat flow through a quantum system? How much energy does it take to perform a quantum computation? How efficiently can a quantum device convert energy into useful work? These are the questions of quantum thermodynamics, and they are deeply intertwined with the challenge of open quantum systems. In particular, the quantum systems under consideration are small, and driven far-from-equilibrium: two conditions where traditional thermodynamics ideas do not apply. Therefore, one needs to fundamentally define the meaning of heat and work to understand how a thermodynamic description may still emerge. This highly active research direction aims to leverage quantum information ideas to formulate thermodynamic descriptions of microscopic far-from-equilibrium systems. Moreover, not only the average heat and work, but also their statistical fluctuations become very relevant at such small scales. By building thermodynamic frameworks directly on top of the more accurate methods developed, it has been possible to derive precise, reliable accounts of energy and entropy flows in driven quantum systems [2,3], as well as fluctuations in currents [4] — results that the standard approach gets wrong or cannot address at all.

**Surprising Physics: Transport and Phases in Open Systems**

When quantum systems are connected to reservoirs — sources and sinks of energy or particles — entirely new phenomena can emerge. Think of electricity flowing through a wire, but now at the quantum scale, where individual electrons behave as waves and interference matters. This is a particularly important technologically relevant situation where open quantum system description is inevitable.

Using frameworks that go beyond memory-less and weak-coupling approximations, we have uncovered phases of transport behavior in open quantum systems that simply have no counterpart in isolated systems [9,10]. Just as water can exist as ice, liquid, or steam depending on conditions, particle and energy currents can behave in qualitatively distinct ways depending on how the system is driven and how it is connected to its environment. Mapping these phases and understanding the transitions between them is both fundamentally fascinating and practically important for designing quantum devices that carry information reliably, also having direct connections with quantum thermodynamics [2].

Engineering Quantum Systems by Design

Instead of accepting whatever behavior a quantum device happens to exhibit, can we engineer the interactions between a system and its environment so that the system behaves in a precisely chosen way?

The answer turns out to be yes — at least for some interesting and useful classes of behaviors. By carefully crafting how a quantum system couples to its surroundings, it is possible to make the system effectively governed by mathematical objects that describe systems where gain and loss are deliberately balanced, and systems where coupling between various degrees of freedom are non-reciprocal. Such systems exhibit remarkable and counterintuitive properties: they can have exceptional sensitivity to tiny perturbations, making them candidates for extraordinarily precise sensors. They can support unusual modes of behavior near special operating points where two distinct states of the system merge into one.

A key question here is providing a rigorous microscopic recipe — not just a mathematical abstraction — for how to actually build such systems from real physical components, with real environments, in a way that is consistent with the fundamental laws of quantum mechanics [11, 12].

**Why This Matters: The Road Ahead**

We are living through a remarkable era. Quantum computers are no longer thought experiments — they exist, they are being improved every year, and they are beginning to tackle problems that ordinary computers cannot. Quantum sensors are achieving precision that redefines how we measure time, gravity, and magnetic fields. Quantum communication promises fundamentally secure transmission of information.

All of these technologies share a common challenge: they are quantum systems living in a noisy, interacting, driven world. The theoretical tools to understand and control them have simply not kept pace with the experimental advances — until now. Our research directly addresses this gap, providing the conceptual foundations and practical methods needed to describe quantum devices as they truly are, not as idealized textbook models.

Whether it is computing the full statistical fingerprint of a quantum current, simulating a many-body quantum chip without uncontrolled approximations, uncovering new transport phases, or designing systems with tailored quantum behavior — each of these threads contributes to the same larger tapestry.

> *A complete and reliable theory of open, driven quantum systems: one that can predict device behavior, guide engineering decisions, uncover new physics, and help humanity realize the full potential of the quantum age. That vision is within reach.*

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# Quantum Communications @IITH


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India's National Quantum Mission (NQM) aims to develop indigenous capabilities in quantum computing, quantum communication, quantum sensing, and quantum materials. Within the quantum communication domain, several research groups in academia are focusing on the development of future quantum networks based on prepare-and-measure networks, entanglement distribution and quantum repeaters based networks.

The Quantum Communications group @IITH is a part of the quantum communications vertical of the NQM. In this article, we discuss about the activities in the simulations and formal analysis subgroup of the quantum communications group. The other subgroup, headed by Prof Naresh Emani (EE), is working on Indium Phosphide (InP) based Photonic Integrated Circuits (PICs) implementation of QKD systems. This promising new technology not only miniaturizes the system footprint, but is also expected to improve phase stability and make the systems amenable to large-scale production.

One of the objectives of the quantum communications vertical of the NQM is to design, deploy and test a prepare-and-measure trusted node Quantum Key Distribution network called Quantum Internet with Local Access (QuILA), across the country.

To support these efforts, we are in the process of developing faithful simulators and digital twins of quantum communication networks. A digital twin is a virtual replica of a physical quantum network that allows experimentation, monitoring, and optimization before deployment. Such models incorporate realistic channel noise, photon losses, quantum memories, and repeater operations. Digital twins help evaluate network behavior under varying traffic conditions and support the design of scalable quantum internet architectures.

Simulation plays a central role in these studies. We employ open-source discrete-event quantum network simulators like SeQUeNCe (Simulator of Quantum Network Communication) to model entanglement generation, swapping, purification, and routing. Such simulators enables evaluation of network performance metrics such as entanglement generation rate, fidelity, latency, throughput, and resource utilization. Simulation studies investigate how different network topologies and routing strategies affect the reliability and efficiency of quantum communication. Indeed, some aspects of security of the system can also be analyzed. For studying some other aspects, we propose to build our own simulators in-house.

Another active area is the development and analysis of routing protocols for quantum networks that are based on entanglement swapping. Unlike classical routing, quantum routing must consider fidelity degradation, decoherence, probabilistic entanglement generation, and limited quantum memory lifetimes. A major research direction is the study of entanglement swapping protocols, which enable the extension of quantum entanglement over long distances without direct transmission of entangled particles across the entire network. Entanglement swapping forms the foundation of quantum repeaters and the future quantum internet. Researchers study shortest-path, fidelity-aware, and resource-aware routing algorithms to maximize end-to-end entanglement quality while minimizing network resource consumption. These protocols are evaluated through simulation environments and digital twin platforms.Current activities include protocol design, performance analysis, resource optimization, and applications in secure communication, distributed quantum computing, and quantum sensing networks.

To ensure correctness and reliability, researchers are increasingly adopting formal methods for protocol verification. Formal verification techniques help prove properties such as correctness, security, deadlock freedom, and behavioral equivalence between protocol implementations and their specifications. For example, Communicating Quantum Processes (CQP) provides a mathematical framework for modeling and analyzing quantum communication systems. CQP extends classical process calculi with quantum operations, allowing rigorous specification of entanglement swapping, teleportation, and repeater protocols. For entanglement swapping based protocols, there are formal method techniques using specification languages based on, for example, Kleene algebra.

Studies using simulators, development of digital twins, design of routing algorithms on entanglement swap based quantum networks, and formal verification through CQP creates a comprehensive framework for studying next-generation quantum networks. These efforts directly support the objectives of India's National Quantum Mission by advancing the design, validation, and deployment of secure and scalable quantum communication infrastructure.

> *"Through advanced simulations, digital twins, quantum routing protocols, and formal verification, IIT Hyderabad is shaping the technologies that will power India's future Quantum Internet under the National Quantum Mission."*

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# Quantum Computers: A New Way to Understand the Universe

KID: 20260107 | Mr Debojyoti Banerjeel, Dr Anurag Tripathi

**Introduction: The Language of the Universe**

At the most fundamental level, everything in our universe from the light in your room to the tiny particles inside an atom is governed by a set of rules called Quantum Field Theory (QFT). While most people think of the world as being made of solid little marbles called particles, physicists see things differently.

In QFT, we imagine the entire universe is filled with invisible fields . Think of an ocean: if the ocean is the field, a ripple or excitation on the surface is a particle. For example, an electron is just a ripple in the electron field. This framework is the backbone of modern physics and helps us predict how the smallest pieces of nature behave with incredible experimental accuracy.

**The Wall: Why Regular Computers Struggle**

Even though we have the rulebook (QFT), solving the equations is incredibly hard both analytically and numerically. To solve these problems on a standard supercomputer, scientists have to break space and time into a grid, or a lattice, much like the pixels on a TV screen. However, standard computers hit a wall because:

**Too Much Data:** As the system gets slightly larger, the amount of memory needed grows exponentially.

**Complex Interactions:** Some systems, like those involving fermions (matter particles), create mathematical sign problems that confuse classical computers.

**Real-Time Action:** Watching how a particle changes and moves

**The Solution: Thinking Like Nature**

In the 1980s, the famous physicist Richard Feynman had a simple but brilliant idea: if nature is quantum, we should use a quantum machine to simulate it. This is where Quantum Computers come in. Unlike regular computers that use bits (0s and 1s), quantum computers use qubits. These qubits can exist in multiple states at once (superposition) and can be linked together (entanglement). This allows them to naturally speak the same language as the quantum fields they are trying to study.

**How It Works! : Translating Fields to Qubits**

To simulate the universe on a quantum chip, researchers follow a few main steps:

Digital Grid: Space is turned into a grid of points.

Mapping: The value of a field at each point is translated into a state that a qubit can understand.

Actual Action: Quantum circuits are used to simulate how these fields change and interact over time, like frames in a movie.

**The Road Ahead**

We are currently in the NISQ era which stands for Noisy Intermediate-Scale Quantum a term coined by John Preskill. This means our current quantum computers are still a bit noisy and prone to errors. We at the Q2 Hub and researchers from around the world are working hard to build better error correction and more efficient algorithms. While we are still in the early stages, the synergy between these two fields, physics and computer science is pushing the boundaries of what humans can understand about the universe.

> *Quantum Field Theory has long been a cornerstone of our understanding of nature, yet many of its mysteries remain unsolved due to computational limitations. Quantum computers offer a fundamentally new way to approach these problems by leveraging the principles of quantum mechanics itself.*

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# Quantum Steps to Smarter Memory: The Rise of Quantum Memory Devices



KID: 20260108 | Mr Prince Kumar & Prof Suryanarayana Jammalamadaka

The rapid growth of digital technologies has created an urgent need for memory devices that are faster, smaller, and more energy-efficient. Conventional memory systems, which typically store one bit per cell, are approaching their physical and operational limits. In our recent work, we explored a new approach based on a simple two-terminal device that can store multiple bits of information within a single unit. By engineering tantalum oxide (Ta2O5)-based memristors, we demonstrate the phenomenon of quantum conductance, where electrical conductance changes in discrete steps rather than continuously. This enables us to achieve stable 6-bit memory storage with 68 distinguishable states. These findings are important not only for high-density data storage but also for emerging areas such as neuromorphic computing and quantum electronics.

**Rethinking Memory for a Data-Driven World**

The modern world runs on data. From smartphones and wearable devices to cloud computing and artificial intelligence systems, the demand for efficient data storage has grown exponentially. Traditional memory technologies, such as dynamic random-access memory (DRAM) and flash memory, rely on binary storage, where each memory cell represents either a 0 or a 1. While this approach has served us well for decades, it limits the amount of information that can be stored within a given area and increases power consumption as devices scale down.

To address these challenges, researchers have been exploring multi-bit memory systems, in which a single device can store multiple levels of information rather than just two. This approach significantly enhances storage density and reduces energy usage. Among the various candidates for next-generation memory, resistive random-access memory (RRAM) has emerged as a strong contender. RRAM devices are based on a simple metal-insulator-metal structure and operate by switching between high- and low-resistance states. Their simplicity, scalability, and compatibility with existing semiconductor processes make them highly attractive for future applications.

**A Simple Device with Complex Physics**

In this work, we focus on a two-terminal device consisting of silver (Ag), tantalum oxide (Ta2O5), and fluorine-doped tin oxide (FTO), as shown in Figure 1a. Despite its simple structure, the device exhibits remarkably rich physical behaviour. Unlike many previously reported multi-bit memory devices that rely on complex three-terminal architectures, our device operates efficiently with just two terminals, reducing fabrication complexity and power requirements.The key to the device operation lies in the formation of nanoscale conducting pathways, known as filaments, within the Ta2O5 layer. These filaments are created by oxygen vacancies, missing oxygen atoms that act as charge carriers.

When an external positive voltage is applied, oxygen ions migrate within the material, leaving behind vacancies that align to form a conductive bridge between the top and bottom electrodes. This process switches the device from a high-resistance state to a low-resistance state. Reversing the voltage polarity disrupts the filament, returning the device to its high-resistance state. This reversible switching forms the basis of memory operation in RRAM devices. The I-V characteristics of the same are shown in Figure 1b.

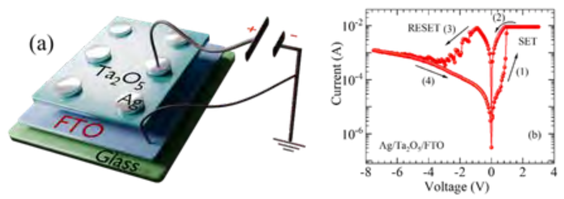


*Figure 1. (a) Schematic representation of the Ag/Ta2O5/FTO RRAM device. (b) I-V characteristics of the Ag/Ta2O5/FTO RRAM device showing that SET happens at positive polarity, while it is negative polarity for the RESET.*

**Quantum Conductance: A Stepwise Journey of Electrons**

One of the most striking observations in our study is the presence of quantum conductance. In conventional systems, electrical conductance changes smoothly with applied voltage. However, when the conducting filament becomes extremely narrow, comparable to the electron's Fermi wavelength and length of the channel is less than electron's mean free path, quantum effects begin to dominate. In this regime, electrons can only pass through discrete channels, resulting in conductance that changes in step-like increments.

The fundamental unit of this quantized conductance is given by:

$G_0 = 2e^2/h = (12.9\ \mathrm{k}\Omega)^{-1} = 7.74809 \times 10^{-5}$ S

where 'e' is the electron charge and 'h' is Planck's constant. Each step corresponds to the opening or closing of a conduction channel within the filament. Interestingly, we observe not only integer multiples of this quantum unit but also half-integer values, indicating more complex transport behaviour.

These discrete conductance levels provide a natural platform for storing multiple bits of information within a single device.

**Experimental Insights and Validation:** To understand the underlying mechanisms, we carried out a series of experimental investigations. Structural analysis (GI-XRD) revealed that the $Ta_2O_5$ layer is amorphous, facilitating the formation of flexible, dynamic conducting filaments. Chemical characterization confirmed the presence of oxygen vacancies, which are crucial for filament formation.

Electrical measurements showed stable bipolar resistive switching with a large difference between high and low resistance states, ensuring reliable memory operation.

We also performed temperature-dependent measurements to probe the nature of conduction. In the low-resistance state, the device exhibited metallic behaviour, while in the high-resistance state, it showed insulating characteristics. The extracted temperature coefficient of resistance ($\alpha \sim 5.28 \times 10^{-4}$ $K^{-1}$) matched well with values reported for oxygen vacancy-mediated conduction, confirming that the filaments are formed by oxygen defects rather than metallic ions. Additionally, conductive atomic force microscopy provided direct evidence of localized conducting channels, further supporting the filamentary conduction model.

**From Binary to Multi-Level Storage**

A major highlight of this work is the ability to achieve multi-level memory storage. By carefully controlling the applied voltage and pulse conditions, we were able to access up to 68 distinct current levels within a single device, as shown in Figure 2a. This corresponds to approximately 6-bit storage, far exceeding the capabilities of conventional binary memory. The quantized conductance states ranged from 0.5 $G_0$ to 18 $G_0$, with a step size of 0.5 $G_0$ (Figure 2b).

This large number of well-defined states demonstrate the potential of these devices for high-density data storage. Importantly, statistical analysis showed that these states are stable and distinguishable, with relatively low variation across multiple cycles. This reliability is essential for practical applications.

**Understanding Electron Transport**

To gain deeper insight into the observed behaviour, we analyzed electron transport using a theoretical framework based on quantum mechanics. Electrons travel through the filament as wave-like entities, and their motion is governed by discrete energy levels known as sub-bands. The number of available sub-bands determines the number of conduction channels and, consequently, the conductance of the device.

As the applied voltage changes, the energy distribution of electrons in the electrodes shifts, leading to variations in the number of occupied sub-bands. This results in changes in conductance that appear as quantized steps. The agreement between theoretical predictions and experimental observations confirms that quantum transport plays a central role in the operation of our device.

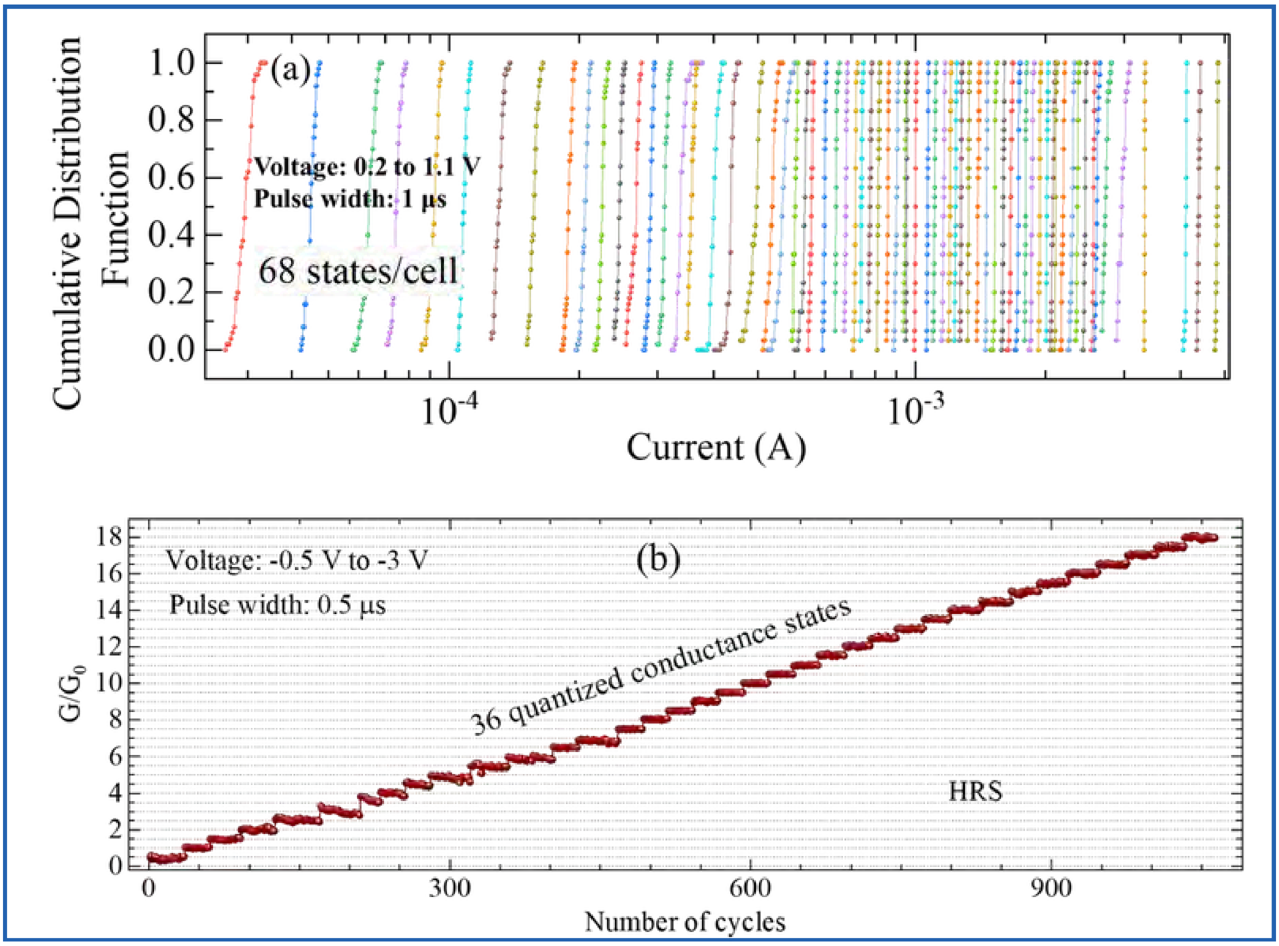


*Figure 2. (a) Multi-level switching (68 states > 6-bit) in a single RRAM, Ag/$Ta_2O_5$/FTO device. (b) Multi-level (> $2^5$ states) conductance quantization steps for Ag/$Ta_2O_5$/FTO device in the HRS state.*

**Challenges and Practical Considerations**
While the results are encouraging, several challenges need to be addressed before these devices can be widely adopted. One of the main challenges is controlling the formation and stability of conducting filaments, as small variations can lead to fluctuations in conductance. Ensuring reproducibility across large numbers of devices is also critical for commercialization.

In our study, we addressed these challenges through careful material design and statistical analysis. Although some variability remains, the conductance states are sufficiently well separated to be reliably distinguished. Continued research will focus on improving device uniformity and scalability.

**Broader Implications and Future Directions**
The implications of this work extend beyond memory technology. Te ability to control conductance at the quantum level opens up new possibilities in several fields. In neuromorphic computing, for example, the multiple conductance states can mimic the behaviour of synapses in the human brain, enabling more efficient artificial intelligence systems. In quantum electronics, understanding and harnessing quantized transport is essential for developing next-generation devices. Looking ahead, future research will explore ways to further increase the number of stable conductance states, reduce variability, and integrate these devices with existing semiconductor technologies. There is also interest in investigating other materials and device architectures that could enhance performance and functionality.

**Reference:**
**Publication**
Prince Kumar, and S. Narayana Jammalamadaka, 6-bit storage and statistical evolution of quantum conductance in $Ta_2O_5$-based memristor device. ACS Applied Electronic Materials. 7(11), 5090–5099. https://doi.org/10.1021/acsaelm.5c00495

**Patent:**
1.S. Narayana Jammalamadaka and Prince Kumar, A memristor device with 5-bit conductance quantization and 6-bit memory capacity and a method of manufacturing the same" Application number: 202441102895 dated 24.12.2024; Granted number: 575583

*Conclusion*

*This work demonstrates that simple oxide-based devices can exhibit complex and fascinating physical phenomena. By combining defect engineering with quantum transport principles, we have shown that it is possible to achieve multi-bit memory storage in a compact and efficient device. The observation of stable quantum conductance and 6-bit storage highlight the potential of $Ta_2O_5$-based memristors for future quantum electronic applications. As the demand for data storage continues to grow, such innovations will play a crucial role in shaping the next generation quantum memory technologies.*

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# The Beauty of Imperfection: How Defects in Materials Shape the Quantum Future



KID: 20260109 | Ms Srijita Chakraborty, Prof Manish K Niranjan

**Summary**

When we think of advanced materials, we often imagine perfectly ordered atomic structures. Surprisingly, some of the most exciting developments in modern materials science emerge not from perfection but from imperfection. Atomic-scale defects, such as missing atoms or structural irregularities-can dramatically alter the electronic, optical, and magnetic properties of materials. In recent years, researchers have discovered that these imperfections can bedeliberately engineered to create functionalities that are essential for emerging quantum technologies. In atomically thin two-dimensional materials, defects can induce magnetism, modify charge transport, and enhance sensitivity to external stimuli, making them promisingcandidates for future quantum devices, spintronic systems, and advanced sensors. Through computational techniques such as Density Functional Theory (DFT), scientists can investigate these effects at the atomic scale and guide experimental efforts toward designing materials with tailored properties.

This article explores how defects, once considered undesirable, are now becoming powerful tools for shaping the future of quantum technology.

**The Quest for Quantum Technologies**

Quantum technology is rapidly emerging as one of the most transformative scientific frontiers of the twenty-first century. Quantum computers promise unprecedented computational capabilities, quantum communication offers fundamentally secure information transfer, and quantum sensors aim to achieve levels of precision beyond the reach of conventionaltechnologies. While these advances often capture public attention, the materials that make such technologies possible receive far less recognition. Just as silicon enabled the digital revolution, the success of quantum technologies depends on discovering and engineering materials capable of supporting quantum phenomena. The search for such materials has become a major focus ofcontemporary research.

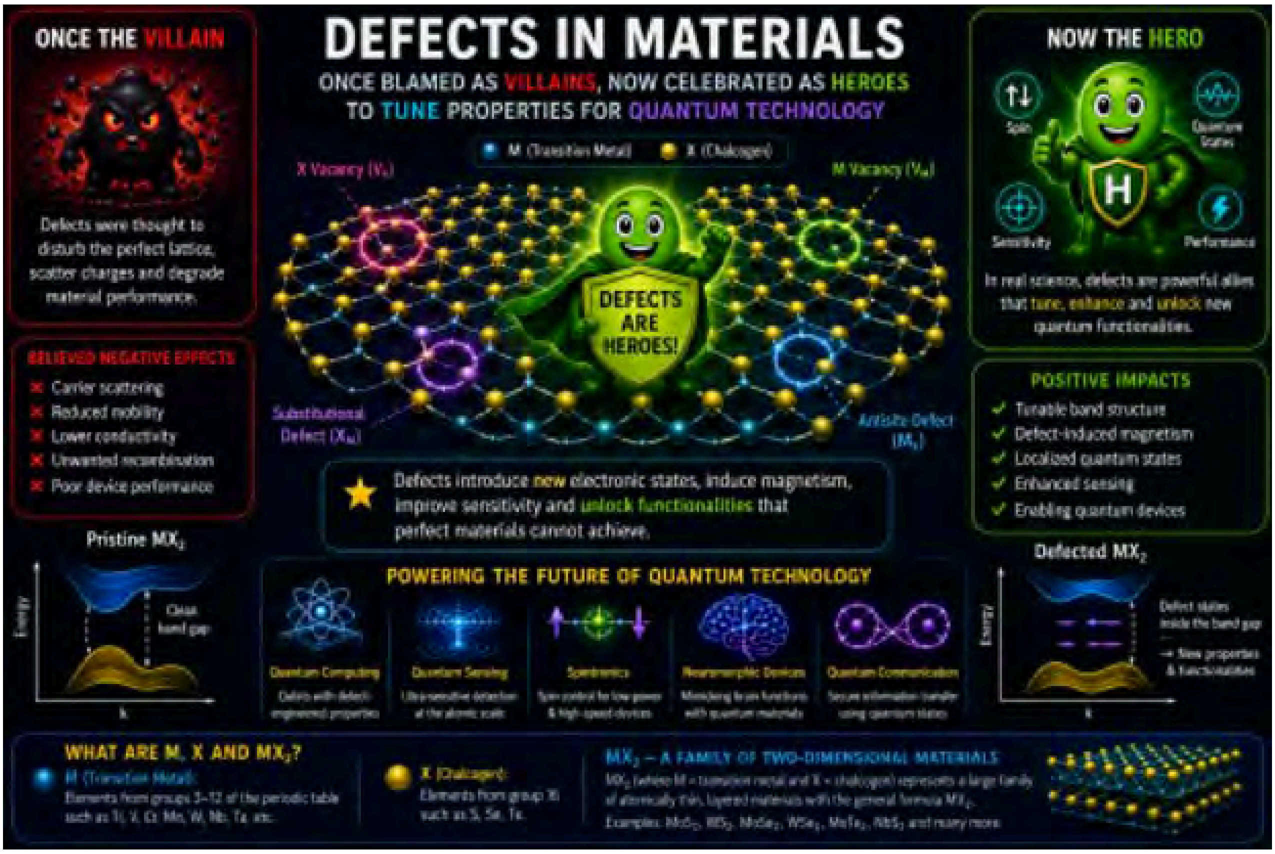


*Figure 1. From Villain to Hero: Schematic illustration showing how defects were traditionally considered detrimental but are now recognized as powerful tools for tailoring material properties.( Image Credit: Generative AI)*

### A New World of Atomically Thin Materials

The discovery of graphene revealed that stable materials can exist in sheets only one atom thick. This breakthrough sparked intense interest in a broader family of atomically thin materials known as two-dimensional (2D) materials. Among these, transition metaldichalcogenides (TMDCs) have attracted significant attention because of their remarkable electronic and optical properties. Unlike conventional bulk materials, electrons in these ultrathin systems experience strong quantum confinement, leading to behaviours that can be highly sensitive to external influences. Their atomic-scale thickness provides an extraordinary opportunity: even the removal of a single atom can significantly influence material properties. This sensitivity makes 2D materials exciting platforms for future quantum technologies.

### When Imperfections Become Opportunities

For decades, defects were viewed as unwanted flaws. In traditional materials engineering, scientists often attempted to eliminate defects because they could reduce efficiency and degrade performance. Modern materials science has revealed a more fascinating story. A defectis simply a departure from perfect atomic order. Examples include missing atoms (vacancies), foreign atoms replacing native atoms (substitutions), or atoms occupying unusual positions within the crystal structure. Although these changes may appear insignificant, they can profoundly alter how electrons behave inside a material. One may think of a city map. Removing a single road or building can redirect traffic patterns throughout an entire neighbourhood. Similarly, removing or replacing a single atom can change the pathways available to electrons, creating entirely new physical properties. This concept forms the foundation of defect engineering—the deliberate use of atomic imperfections to tailor material behaviour.

### Unlocking New Electronic and Magnetic Properties

One of the most remarkable consequences of defect engineering is its ability to create properties that do not exist in pristine materials. Defects can introduce localized electronic states, modify conductivity, and alter interactions between electrons. In some cases, they can even generate magnetism in materials that are naturally non-magnetic.This phenomenon isparticularly important for spintronics, a field that seeks to exploit not only the charge of electrons but also their spin.

Spin-based devices could potentially process information more efficiently while consuming less energy than conventional electronic systems.The ability to induce and control magnetic behavior through defects opens exciting possibilities for futurememory devices, logic circuits, and quantum information technologies.What was once considered a flaw is increasingly becoming a functional design element.

### Looking Inside Materials with Supercomputers

Understanding the behavior of individual atoms is an enormous challenge. Many of the processes that determine material performance occur at scales far too small for direct observation.This is where computational materials science plays a crucial role.Researchers use quantum-mechanical simulations to investigate how atoms and electrons interact withinmaterials. One of the most widely used approaches is Density Functional Theory (DFT), which enables scientists to predict material properties from fundamental physical principles.Through DFT calculations, researchers can create virtual models of materials, introduce specific defects, and study their impact on electronic structure, charge transfer, magnetism, and stability.Such computational studies accelerate discovery by identifying promising material systems before experimental fabrication begins.

- ### Defects and the Future of Quantum Devices

As researchers gain greater control over atomic-scale imperfections, new opportunitiescontinue to emerge. Defect-engineered materials are being explored for applications in quantum computing, quantum sensing, spintronics, and advanced nanoelectronics. Their exceptional sensitivity to environmental changes also makes them attractive candidates for future sensing platforms capable of detecting extremely small signals. Emerging materials such as Janus two-dimensional systems, which possess intrinsic structural asymmetry, offeradditional avenues for tuning electronic and spin-related properties. Combined with defect engineering, these materials may enable functionalities that are difficult to achieve in conventional systems. Although many scientific and technological challenges remain, the progress achieved over the last decade has been remarkable.

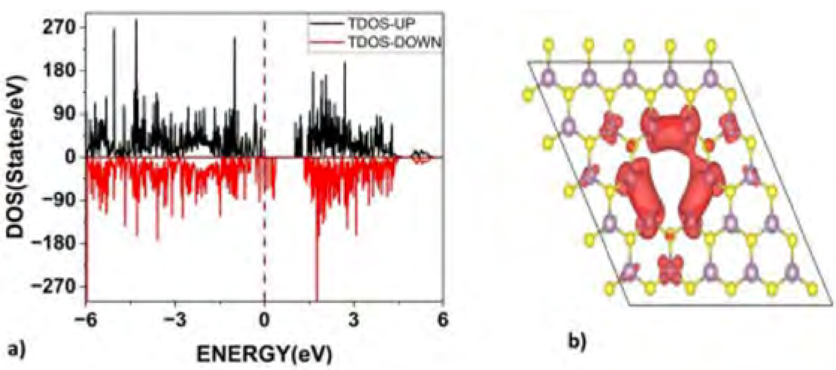


*Fig.2: a) Total density of states, and b) Spin density in MoS2 monolayer with V1Mo+6S configuration in, b) Spin density plot of V1Mo+6S in MoS2 monolayer*

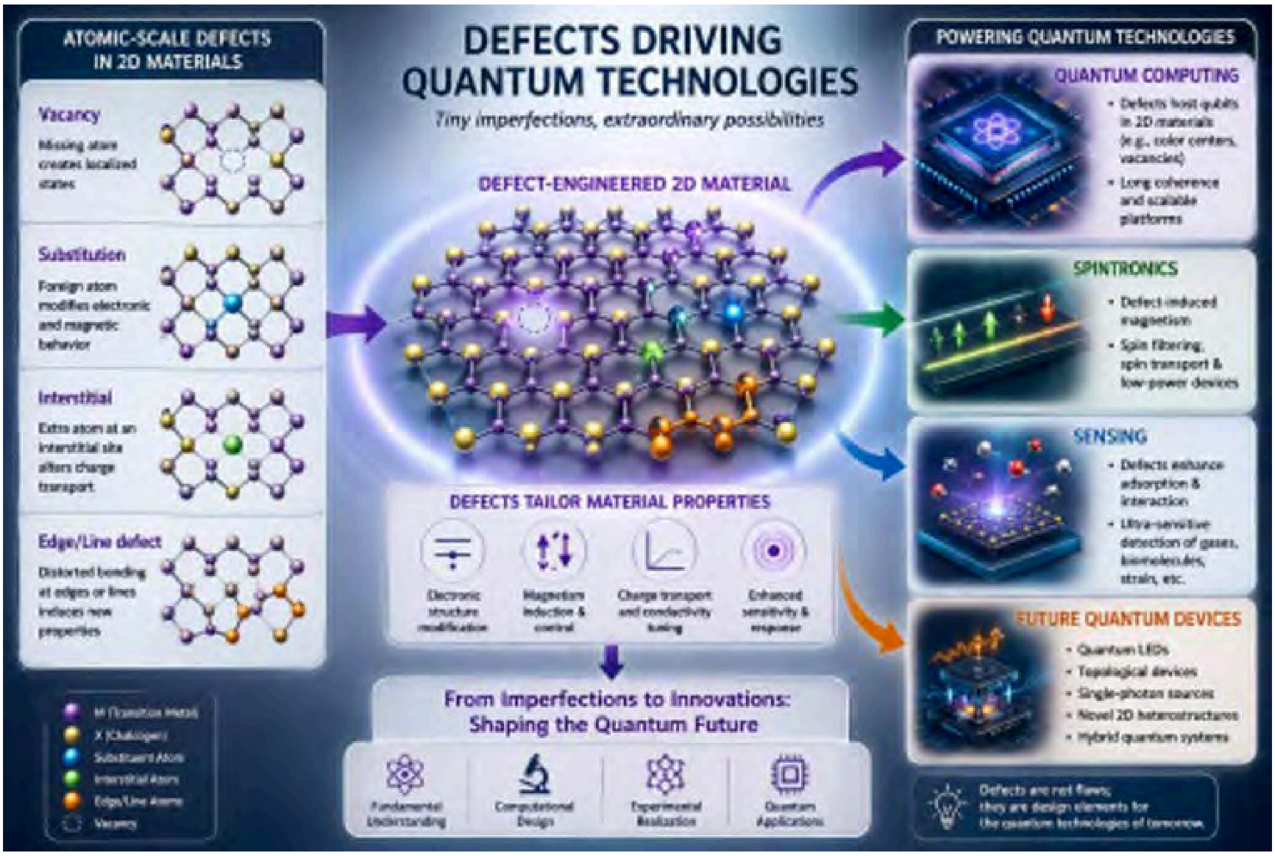


*Figure 3. Defects Driving Quantum Technologies: Conceptual illustration linking defect engineered materials to quantum computing, spintronics, sensing, and future quantum devices. (Image Credit: Generative AI)*

**Looking Ahead**

The history of science repeatedly demonstrates that breakthroughs often emerge from unexpected places. In the world of quantum materials, one such surprise is the realization that imperfections can be extraordinarily useful.Tiny atomic defects, once regarded merely as flaws, are now recognized as powerful tools for engineering new functionalities. By learning to manipulate matter atom by atom, researchers are transforming imperfections intoopportunities and opening pathways toward next-generation quantum technologies. The future of quantum devices may not be built upon perfect materials. Instead, it may be shaped by carefully engineered imperfections that unlock entirely new possibilities.

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> *“The concepts, scientific perspective, and overall structure of this article were developed by the author based on original research interests, academic knowledge, and independent exploration of the subject. Generative AI tools were used solely to assist with language refinement, grammatical corrections, and formatting improvements to align the manuscriptwith the feature-article requirements of the KirIITH newsletter. All scientific content, interpretations, and conclusions remain the author's own.”*

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# The Hardware Approach to Quantum Key Distribution

**KID: 20260110** | Ms Ritu, Dr Naresh Kumar Emani

Quantum Key Distribution (QKD) has come a long way from laboratory experiments to field deployments. The majority of the current hardware implementations involve bulky optical components (Lasers, Modulators, Detectors, etc) housed in a 2U-rack-mounted chassis, with a dark optical fiber serving as a quantum channel between Alice and Bob. These implementations are limited by their size, weight, cost, reliability, and scalability. At IITH, the research group of Dr Naresh Emani (EE) collaborates with the theory group led by Prof. M. V. Panduranga Rao (CSE) on the hardware aspects of QKD.

The quantum communication hardware group is developing Photonic Integrated Circuits (PICs) and the associated high-speed electronics for QKD. PICs are the photonic analogue of widely used electronic integrated circuits, and enable the integration of lasers, modulators, photodetectors and waveguides on a monolithic platform. Using this technology, the Quantum Transmitter, which is currently a 2U-rack size block, can be miniaturized into a USB-pluggable device. The development of this hardware requires expertise at the intersection of photonics, high-speed electronics, and quantum science.

Panel (a) of the accompanying figure shows a block-level diagram of one variant of QKD, the differential phase-shift QKD. In this implementation, the light generated by a laser is modulated into pulses representing 0 and 1. The phase between the pulses is then modulated by a phase modulator, and the output is attenuated to a single-photon level.

A combination of the laser and phase modulator constitutes a QKD transmitter (Alice). Achieving average photon counts below 1 is necessary to ensure the security of the QKD protocol, and this is much harder than it sounds(see inset "How bright is a single photon?")! The receiver (Bob) receives the stream of optical pulses and determines whether there is a phase shift between consecutive pulses.

This block can be added as a floating box

> *How bright is a single photon? For example, a typical laser pointer we use in presentations emits a few mW of optical output, and contains about $3x10^{15}$ photons/second at a wavelength of ~630 nm, - a million-billion photons are emitted every second. Many technological innovations in RF electronics and photonics are needed to reduce the photon count to a single photon level.*

The bottom panel shows an optical micrograph of a DFB laser (~400 um x 220 um area) fabricated on an 8 mm x 2 mm Indium Phosphide chip. The DFB laser is one component that is needed in a QKD transmitter. It emits light which can be modulated and attenuated and finally launched into an optical fiber. The measured optical characteristics – LIV curve and spectral characteristics of the DFB laser are shown in figure 1(c). Behind the small tidbits discussed here, there are countless technical details about the hows and whys of the hardware implementation.

Closing Thoughts: While there is a lot of emphasis on quantum science, it is equally important to study engineering technologies (many of them classical!), which is necessary to make the promise of quantum science a practical reality.

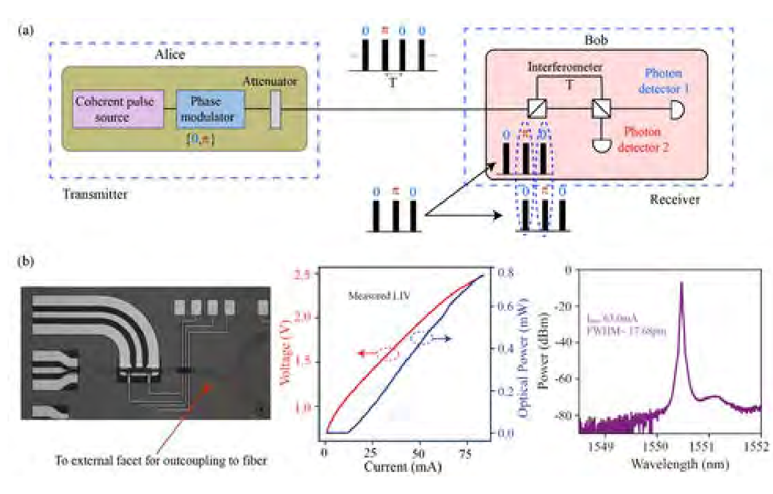


*Figure 1. (a) Schematic illustration of the components necessary for DPS QKD. The QKD transmitter (Alice) is connected to the QKD receiver (Bob) through a channel. (b) An optical micrograph of a DFB laser fabricated through an external foundry, and representative results showing its IV and spectral performance. The characterisation was performed in the lab at the IITH setup with support from the National Quantum Mission.*

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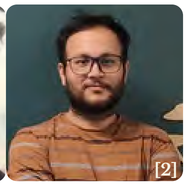
# Why Error Correction is the Key to the Quantum Age


KID: 20260111 | Mr Akash Kumar Saw, Dr Sangkha Borah

**Abstract**
Quantum computation holds the potential to solve problems that would take classical supercomputers millennia, from simulating molecular systems for drug discovery to optimizing global logistics. Yet, the very physics that gives quantum computers their power—the delicate phenomena of superposition and entanglement—also makes them incredibly fragile. A stray photon, a microscopic thermal fluctuation, or electromagnetic noise can corrupt quantum states, causing computational errors before a calculation can finish. This article explores the central challenge of the quantum era: Quantum Error Correction (QEC). QEC is not just an engineering optimization; it is the theoretical foundation upon which the future of scalable, fault-tolerant quantum technology must be built. Here, we outline the physics of qubit fragility, explain why classical error-correcting techniques fail in the quantum regime due to fundamental laws of nature, and discuss how physicists are using quantum entanglement to mend the magic of the subatomic world.

The Golden Promise and the Fragile Truth
To understand why quantum systems require error correction, we must examine the difference between classical and quantum information. A classical computer stores and processes information in bits, represented physically by transistors that are either completely on (1) or off (0). A classical bit is robust, requiring billions of electrons to transition between states, making it highly resistant to small environmental disturbances.

A quantum computer, however, operates with qubits. Unlike a classical bit, which represents a binary choice, a qubit is a two-state quantum system that can exist in a superposition of both states simultaneously. Think of a classical bit as a light switch that is either up or down. A qubit is more like a spinning coin. While the coin is spinning on a tabletop, it is not strictly heads or tails; it exists in a dynamic mixture of both possibilities. This superposition allows a quantum computer to explore vast computational pathways in parallel. Qubits also exhibit entanglement, a quantum connection that links the states of multiple qubits such that measuring one instantly dictates the state of another, regardless of distance.

This extra structure makes quantum computing incredibly powerful, but it comes at a steep price. The spinning coin is easily disturbed; a light tap on the table will knock it flat. Similarly, qubits are extremely sensitive to their surroundings. A tiny fluctuation in temperature, a pulse of electromagnetic radiation, or a microscopic defect in the hardware can interact with the qubit, causing it to lose its quantum character. This process, known as decoherence, destroys the delicate superposition and turns the quantum processor into a sluggish classical calculator.

If we cannot protect qubits from decoherence, the quantum revolution will remain a mathematical curiosity.

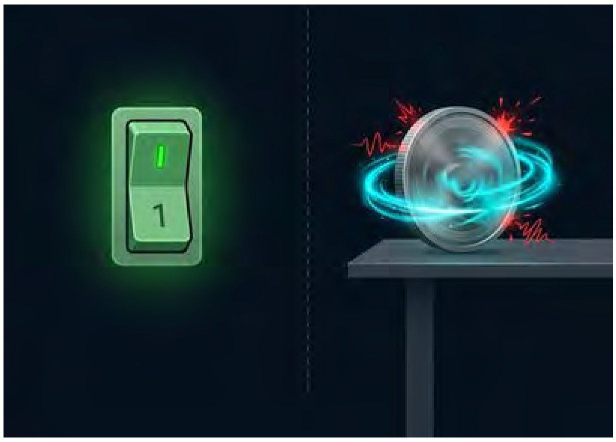


*figure. 1. The Threat of Decoherence. A classical bit behaves like a stable switch that remains in its defined state. In contrast, a qubit behaves like a delicate spinning coin, easily knocked out of its superposition by environmental disturbances (such as heat, stray electromagnetic fields, or material defects).*

**Why We Can't Just Copy-Paste: The Quantum Catch-22**
In classical computing, error correction is a solved problem. If we want to protect a classical message from being corrupted by static noise, we use redundancy. For example, to send a single bit `0` or `1`, we can simply repeat it three times as `000` or `111`. If static noise flips one bit during transmission, turning `000` into `010`, the receiver can run a majority vote: since there are more zeros than ones, the corrupted bit is corrected back to `0`. If we need higher reliability, we make more copies. Unfortunately, this straightforward copy-paste method is forbidden in the quantum world by two fundamental laws of quantum mechanics.

**The first law is the No-Cloning Theorem.** Discovered in 1982, this theorem proves that it is physically impossible to create an identical copy of an arbitrary, unknown quantum state. If you have a qubit in an unknown superposition, you cannot duplicate it into three identical qubits to run a majority vote. The moment you try to copy it, you fail.

The second law is the Measurement Collapse. In quantum physics, observing a system forces it to choose a definite state. If you measure a qubit in superposition to see if it has suffered an error, you destroy the very superposition that made it valuable. You would be like an overprotective reader who burns a book to check if the text has been smudged.

This creates a profound paradox: we must detect and correct errors in our qubits, but we cannot copy them to build redundancy, and we cannot look at them to check if they are broken. This is the quantum catch-22.

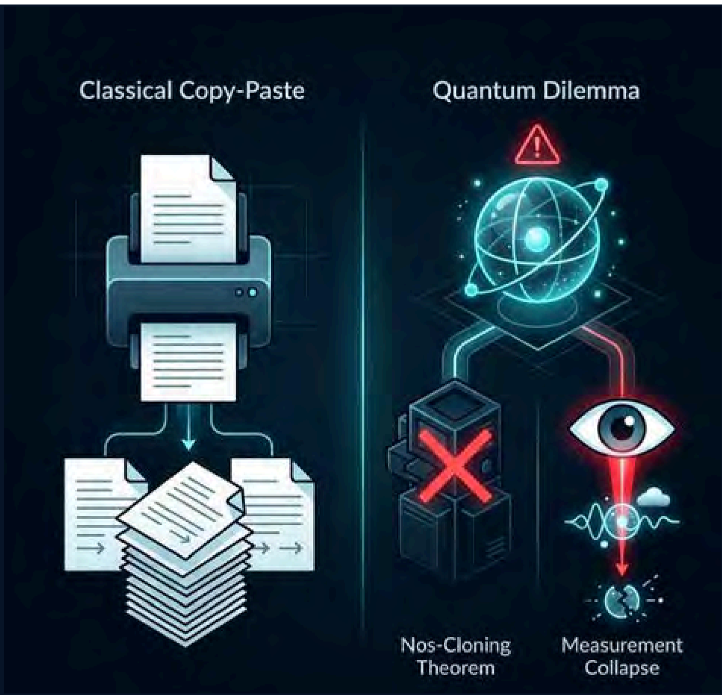



*figure. 2. The Classical vs. Quantum Correction Dilemma. Classical error correction replicates data (copy-paste) and checks states directly. In the quantum regime, this is blocked by two laws of physics: the No-Cloning Theorem (which forbids copying unknown quantum states) and the Measurement Collapse (which destroys superposition if the qubit is directly observed).*

**Entanglement to the Rescue: The Mechanics of Quantum Healing**

To resolve this paradox, physicists had to think outside the classical box. In 1995, Peter Shor published a landmark paper showing that quantum error correction is indeed possible. Instead of copying a quantum state, Shor showed that we could distribute the information of a single "logical" qubit across a larger network of entangled "physical" qubits.

Entanglement allows us to write the information of one qubit into the correlations between multiple qubits. For instance, in Shor's code, one logical qubit is encoded into nine physical qubits. Because the information is stored globally in the connections between the qubits rather than in any single physical qubit, the system becomes resilient to localized damage.

If environmental noise disturbs a single physical qubit, the overall logical state remains intact.
But how do we find the error without measuring the data and collapsing the superposition? Physicists use helper qubits, called ancilla qubits, which are entangled with the data qubits. Instead of measuring the data qubits directly, we perform joint measurements on the ancilla qubits. These measurements are carefully designed to extract only the "syndrome"—a mathematical clue that reveals whether an error occurred and where it is located, without revealing anything about the actual data stored in the qubits.

Once the syndrome is read, we can apply a correction gate to the corrupted physical qubit to reverse the damage. It is like detecting that a house's foundation has shifted by measuring the distance between the walls, without looking at what is inside the house.

**The Blueprint of a Resilient Machine: Surface Codes and Beyond:** Translating these theoretical concepts into working hardware is one of the greatest engineering challenges of our time.

Today's quantum computers, known as Noisy Intermediate-Scale Quantum (NISQ) devices, contain dozens of physical qubits, but they are too noisy to sustain long computations.

To transition from the NISQ era to fault-tolerant quantum computing, where machines can run algorithms containing millions of steps, we must implement advanced QEC architectures. The leading candidate is the surface code. In a surface code, physical qubits are arranged in a two-dimensional grid, resembling a chessboard. Some qubits store the computational data, while others act as ancillas to constantly monitor their neighbors for bit-flips and phase-flips.

The catch is the overhead. To create a single, error-free logical qubit, we need a massive number of physical qubits. If the physical qubits are moderately noisy (with an error rate of about 0.1%), we might need upwards of a thousand physical qubits to construct one logical qubit. To run a complex algorithm requiring hundreds of logical qubits, we would need a quantum processor with hundreds of thousands of physical qubits. Hardware developers working with superconducting circuits, trapped ions, and neutral atoms are racing to improve physical error rates below the critical threshold so that the number of physical qubits required per logical qubit can be dramatically reduced.

By modeling these complex noise environments, we are developing smarter, more adaptive error detection schemes. This research requires close collaboration between physicists, who understand the materials and hardware, and computer scientists, who develop the decoding algorithms that process error syndromes. The journey of a PhD scholar in this field is filled with behind-the-scenes trials—debugging code that simulates thousands of noisy quantum gates, wrestling with the abstract mathematics of tensor networks, and collaborating across disciplines to find practical paths to fault tolerance.

*figure. 3. Syndrome Measurement via Entanglement. A logical qubit is built by entangling data qubits with helper (ancilla) qubits. By measuring only the ancilla qubits, we extract the "error syndrome" (identifying bit-flips or phase-flips) and apply corrections without observing or collapsing the delicate quantum data.*

Yet, every small improvement in a code's threshold brings us a step closer to the quantum future.

> *While headlines often celebrate the growing number of qubits in modern processors, the true milestone of the quantum age will not be how many qubits we can pack onto a chip, but how effectively we can correct them. Quantum error correction is the silent hero of quantum technology. It is the bridge that will carry us from fragile laboratory experiments to robust machines capable of design-on-demand materials, breakthrough pharmaceuticals, and secure global communications. By mending the magic of quantum mechanics, we are transforming the most delicate physics of the universe into the most powerful technology on Earth.*

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# A Nation That Builds, Leads: The Builder's Path to a Viksit Bharat


ON February 28, India celebrates National Science Day, marking Sir C.V. Raman's groundbreaking discovery of the Raman Effect, which allowed scientists to understand molecular structures by studying how they interact with light. Raman's work also demonstrated that fundamental scientific discoveries could emerge from India through curiosity and perseverance. Through this National Science Day, India is not only celebrating a breakthrough scientific discovery, but also its building capability. Raman and his students conducted ingenious experiments that revealed a new phenomenon through an instrument that he has built, which is now called world over as Raman Spectroscope. This work earned India its first Nobel Prize in the sciences, and the world took notice of it.

About 6 months back, I was in Shimane University, to be a part of unveiling ceremony of Sir CV Raman's bust, and Shimane became the first Japanese University to have an Indian Scientist's bust on its campus. Shimane has a Centre for Raman Spectroscopy, which is an example of the global impact of this discovery and invention. I am fortunate that I will be in Shimane University to address their faculty and students on our National Science Day.

Nearly a century after the Raman Spectroscope was built, the National Science Day should ask us a deeper question: Are we still building things that make India globally proud?

India has seen remarkable growth over the past decades. We are a vibrant emerging economy with enormous human capital. Much of our success has come from providing valuable services to the rest of the world, but on the other hand, we depend heavily on imported technologies and advanced research tools from other countries.

To become a developed country (Viksit Bharat), we need to design and build our own technologies and products with the highest global standards, which drive global economy.

To understand how we can achieve this across the broader technological spectrum, it is useful to peep into India's progress in areas such as space, atomic energy and missile technology. Given the critical nature of these sectors, India built the technology from scratch. We designed our own launch vehicles, developed nuclear capabilities, and engineered world-class missile systems. When compelled to rely on us, we rose to the occasion and built globally acclaimed technologies.

However, when technology is readily available for import, we often adopt rather than invent. By the time we absorb one generation of imported technology, the exporting nation has moved many steps ahead in research and development.

On the National Science Day, we should not only celebrate scientific discovery but also renew our commitment to becoming a nation of builders. This transformation cannot take seed only at centers of higher education. It must be ground up, beginning right from our schools.


Today, too many young minds are channeled into a narrow pathway of entrance examinations. The obsession with a single metric of merit has unintentionally dampened creativity. Children who once played sports, engaged in music, tinkered with gadgets, or built small experiments are often asked to set aside everything to prepare for competitive exams, which stifles curiosity. Our definition of academic excellence in schools must not come at the cost of imagination. If we want India to become a technological superpower, we must tell our school going students that building matters.

Imagine a system where higher education institutions recognise not just entrance exam scores but also demonstrated innovations — a prototype built, a product designed, a real-world problem solved. This will ensure that schools across the country establish tinkerer labs, maker spaces, and innovation studios, not as extracurricular activities, but as integral parts of learning. Teachers are trained, and students are incentivised to conceptualise and create prototypes of novel and original solutions rather than memorising content. When young people know that their ability to build is valued, they will naturally build more.

Globally, many leading universities evaluate applicants holistically, including portfolios, projects, initiatives, and creativity. Students submit videos, demonstrate prototypes, and present evidence of what they have created, broadening the definition of merit.

If India's top higher educational institutions were to open their doors wider to innovators and builders, it could lead to a bottom-up transformation, where, instead of being pigeonholed into a rigid definition of learning, students would rediscover the joy of experimentation.

Higher education must also rethink how it values "building." Can a market-ready product or medical device be recognised like a research paper or thesis? At IIT Hyderabad, this shift has begun with product-driven degrees, where innovation itself can serve as the thesis.

Higher education institutions also have reason to introspect. Do we sufficiently reward building within our academic structures? If a doctoral student develops a transformative product that reaches the market, can that be recognised on par with a research paper? If an MTech student creates a deployable medical device, can it be used to award the degree? In some of our programs at IIT Hyderabad, we have begun experimenting with product-driven degrees, where the product itself serves as the thesis.

The National Science Day reminds us that discovery has a ripple effect through time. Raman's work did not remain confined to a laboratory notebook; it revolutionised spectroscopy and influenced generations of researchers in physics and chemistry.

If India is to become a truly developed nation, we must value builders as much as rank-holders. When students see that creating solutions, developing products and solving real problems are recognised alongside examination performance, education will naturally shift from memorisation to meaningful innovation. Sir C.V. Raman showed that the original discovery from India can influence the world. Our task now is to nurture a generation that not only excels in knowledge but also applies it to build technologies for the nation. That shift from learning to create, and from adapting to leading will define India's journey to a Viksit Bharat.

On this National Science Day, let us not only celebrate a discovery from the past, but reimagine education so that we can become a nation that builds.

IITH is planning to lead the country from the front through a supernumerary "Builders Quota" to admit students to its BTech program based in their building capabilities in the school. Once such students are admitted, they can take a semester break in the first semester itself, to demonstrate their building capabilities and earn credits. These students also can also take a complete break from studies up to 5 years at the end of second year with a Diploma to pursue their startup journey.

Hans India

# Aim to boost research and skills in critical minerals

**Mahindra University and IIT Hyderabad partner to strengthen research, training, and start-up ecosystems in critical minerals, sustainable mining, and advanced industrial technologies**

HYDERABAD

Mahindra University and the Indian Institute of Technology Hyderabad (IITH) have signed a strategic Memorandum of Understanding (MoU) to establish a long-term partnership in research, education, training, and innovation, with a strong focus on Critical Minerals, sustainable mining, and advanced industrial processes. The collaboration seeks to strengthen India's capabilities in the exploration and processing of Critical Minerals—an area of growing national importance—by leveraging Mahindra University's interdisciplinary academic approach and IIT Hyderabad's robust research ecosystem. The partnership will span key domains such as iron ore beneficiation, coal and mineral processing, ironmaking and steelmaking, mining waste utilisation for infrastructure, extraction of critical and rare earth minerals, and process modelling and simulation. In addition to conventional mining research, the MoU covers emerging areas including AI and data analytics in mining, Mining 4.0, autonomous systems such as drones and self-driving vehicles, and incubation support for start-ups and innovators. These initiatives aim to translate advanced research into scalable technologies while developing a highly skilled workforce for India's mineral and manufacturing sectors.

Under the agreement, Mahindra University will function as a SPOKE Institute for a Centre of Excellence (CoE) at IIT Hyderabad, enabling structured collaboration among faculty, researchers, and students from both institutions. The partnership will be operationalised through joint research projects, faculty and student exchanges, and shared access to laboratories and academic infrastructure. The Ministry of Mines, Government of India, has recognised seven institutes—four IITs and three R&D laboratories—as Centres of Excellence under the National Critical Mineral Mission (NCMM), with IIT Hyderabad being one of the four IITs. This recognition is a key step toward fulfilling NCMM's objective of advancing research and technology development in Critical Minerals.


Commenting on the partnership, Dr. Yajulu Medury, Vice Chancellor, Mahindra University, said the collaboration directly addresses national priorities under India's Critical Mineral mission and promotes sustainable, indigenous technological solutions through research-led education.

Prof. B. S. Murty, Director, IIT Hyderabad, said India's transition toward self-reliance in Critical Minerals and resource-efficient industrial processes requires sustained academic collaboration. He noted that the partnership would expand IITH's research and training ecosystem, fostering multidisciplinary engagement and translating scientific knowledge into real-world technologies and skilled manpower.

The MoU places strong emphasis on capacity building and skill development. Planned initiatives include specialised training programmes for mining professionals, elective and certificate courses in the Critical Minerals sector, a proposed master's programme in minerals and coal processing, and short-duration programmes for working professionals. The collaboration also envisages seed funding and incubation support for start-ups and MSMEs, along with engagement with venture capital firms to aid commercialisation of research outcomes. Designed as a long-term engagement governed by the academic frameworks of both institutions, the partnership aims to advance knowledge, nurture skilled professionals, and support Atmanirbhar Bharat by strengthening India's leadership in Critical Minerals and sustainable industrial technologies.

Hans India

# IIT Hyderabad hosts UKRI symposium on 19th-century studies

HYDERABAD

The Indian Institute of Technology Hyderabad (IIT H) strengthened its global academic presence by hosting the UKRI International Symposium on Nineteenth-Century Studies titled "Transnational Encounters in/through South Asia." Organised by the Public Humanities Initiative (PHI Centre) under the leadership of Dr. Shuhita Bhattacharjee, in collaboration with Kingston University, UK, the event marked the first symposium of its kind in South Asia.

The symposium stemmed from a major UK Research and Innovation (UKRI) grant aimed at expanding collaborative research on nineteenth-century Indo-British history, with IIT Hyderabad serving as the lead Indian partner. Scholars from India, the United Kingdom, and the United States gathered to examine colonial encounters, gendered histories, visual archives, and cultural exchanges that shaped South Asia during the long nineteenth century.

Keynote addresses were delivered by Dr. Tara Puri of the University of Bristol, who explored colonial photographic archives of Indian women, and Prof. Supriya Chaudhuri, Professor Emerita at Jadavpur University, who analysed representations of affect in nineteenth-century texts and visual materials. Other contributors included scholars from the University of Edinburgh, University of Warwick, University of Birmingham, University of Roehampton, University of Exeter, and institutions in the United States, reflecting the symposium's international scope. Over two days, discussions addressed colonial exhibitions, performance cultures, and embodied gendered encounters, while drawing connections between historical research and contemporary issues such as climate change, public health inequities, and sexual violence legislation. Participants highlighted how historical inquiry continues to inform present-day social and political debates.

A major outcome was the launch of the Nineteenth-Century Diversities Research Network (NCDRN)—the first South Asian network dedicated to nineteenth-century studies. Established by Dr. Bhattacharjee in collaboration with Dr. Eadaoin Agnew of Kingston University, the network positions IIT Hyderabad as a key hub in an emerging global consortium on nineteenth-century research and public humanities.

International scholars praised the initiative for fostering interdisciplinary and cross-regional dialogue. Faculty leaders at IIT Hyderabad welcomed the network as a model of public-spirited, interdisciplinary scholarship.

IIT Hyderabad Director Prof. B S Murty congratulated the organisers and urged researchers to highlight India's rich cultural heritage through historical studies.

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ఆంధ్రజ్యోతి

ఐఐటీహెచ్‌లో ఘనంగా జాతీయ మెటలర్జిస్టుల దినోత్సవం

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కందిలి

కార్మికుల పిల్లల్లో.. ప్రేరణ రగిల్చేలా!

జనం పవర్

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ఆరోగ్య పరిశోధనలో సాంకేతిక విప్లవం

- ఐఐటీ హైదరాబాద్ ఆధ్వర్యంలో జాతీయ స్థాయి వర్క్‌షాప్
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కృత్రిమ మేధస్సుతో కచ్చితమైన ఫలితాలు..

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RNI No. TEL/25/A0888
తెలుగు దిన పత్రిక

మహీంద్రా యూనివర్సిటీ ఐఐటీ హైదరాబాద్ మధ్య కీలక ఒప్పందం

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http://epaper.gandeevam.in
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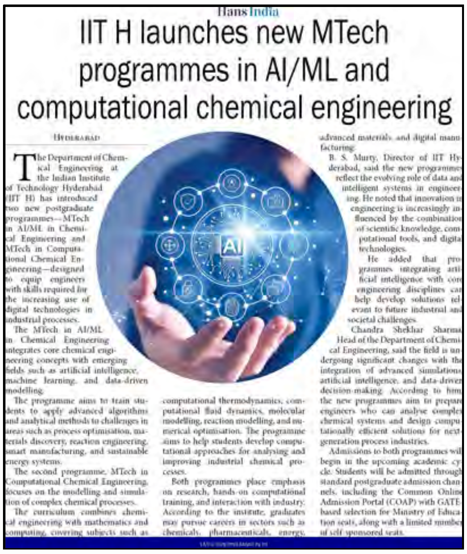
భారత శక్తి

ఐఐటీ హైదరాబాద్ ఎక్స్‌పోజర్ విజిట్ కు తరలివెళ్లిన పారిశుద్ధ్య కార్మికుల పిల్లలు



Hans India

# IIT H launches new MTech programmes in AI/ML and computational chemical engineering

HYDERABAD

The Department of Chemical Engineering at the Indian Institute of Technology Hyderabad (IIT H) has introduced two new postgraduate programmes—MTech in AI/ML in Chemical Engineering and MTech in Computational Chemical Engineering—designed to equip engineers with skills required for the increasing use of digital technologies in industrial processes.

The MTech in AI/ML in Chemical Engineering integrates core chemical engineering concepts with emerging fields such as artificial intelligence, machine learning, and data-driven modelling.

The programme aims to train students to apply advanced algorithms and analytical methods to challenges in areas such as process optimisation, materials discovery, reaction engineering, smart manufacturing, and sustainable energy systems.

The second programme, MTech in Computational Chemical Engineering, focuses on the modelling and simulation of complex chemical processes.

The curriculum combines chemical engineering with mathematics and computing, covering subjects such as computational thermodynamics, computational fluid dynamics, molecular modelling, reaction modelling, and numerical optimisation. The programme aims to help students develop computational approaches for analysing and improving industrial chemical processes.

Both programmes place emphasis on research, hands-on computational training, and interaction with industry. According to the institute, graduates may pursue careers in sectors such as chemicals, pharmaceuticals, energy, advanced materials and digital manufacturing.

B. S. Murty, Director of IIT Hyderabad, said the new programmes reflect the evolving role of data and intelligent systems in engineering. He noted that innovation in engineering is increasingly influenced by the combination of scientific knowledge, computational tools, and digital technologies.

He added that programmes integrating artificial intelligence with core engineering disciplines can help develop solutions relevant to future industrial and societal challenges.

Chandra Shekhar Sharma, Head of the Department of Chemical Engineering, said the field is undergoing significant changes with the integration of advanced simulations, artificial intelligence, and data-driven decision-making. According to him, the new programmes aim to prepare engineers who can analyse complex chemical systems and design computationally efficient solutions for next-generation process industries.

Admissions to both programmes will begin in the upcoming academic cycle. Students will be admitted through standard postgraduate admission channels, including the Common Online Admission Portal (COAP) with GATE-based selection for Ministry of Education seats, along with a limited number of self-sponsored seats.


Hans India

# IIT H hosts MSME tech connect to strengthen industry–academia collaboration

HYDERABAD: MSME Tech Connect 2026 was inaugurated at the Indian Institute of Technology Hyderabad, launching a three-day national platform focused on accelerating technology commercialisation and strengthening India's MSME ecosystem.

Organised by the Technology Transfer Office of IIT Hyderabad under the MSME-SCIP Programme of the Ministry of Micro, Small and Medium Enterprises, Government of India, the event brings together innovators, startups, MSMEs, corporates, investors, research institutions and policymakers to fast-track the journey of technologies from lab to market.

The programme features a large-scale technology exhibition and demonstrations, industry-technology matchmaking sessions, investor and industry pitch forums, technology transfer and licensing clinics, as well as expert talks and panel discussions. Cutting-edge patents, prototypes and industry-ready solutions are being showcased across sectors including AgriTech, HealthTech, AI and Data, Robotics, Electronics, Clean Energy, Manufacturing, Mobility, Aerospace and Pharmaceuticals.

MSMEs are being provided guidance on government schemes, including reimbursement support for intellectual property acquisition, and are engaging directly with research labs, incubators, accelerators and funding agencies.

C.S.S. Rao, IEDS, Joint Director and Head of Office, MSME-Development & Facilitation Office, Hyderabad, emphasised that innovation must translate into employment generation, stronger MSMEs and measurable economic growth. He noted that the platform aims to bridge academic research with industry needs.

Guest of Honour Dr. Louise Boisen, Counsellor–IPR, Royal Danish Embassy, highlighted the importance of robust intellectual property frameworks and global innovation partnerships.

IIT Hyderabad Director Prof. B. S. Murty said the institute's innovation ecosystem supports startups, patenting and industry collaboration, aligning with the event's goal of enabling scalable growth for MSMEs.

The event is expected to foster new partnerships, licensing agreements and pilot deployments over the coming days.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# YOU CAN'T BUILD VIKSIT BHARAT WITHOUT INNOVATION: IIT HYD DIRECTOR

"I want IIT Hyderabad to be remembered as a place where innovation flourished"
Prof B S Murty, Director, IIT Hyderabad

EXCERPTS:

Recent and upcoming academic and institutional launches


గాండీవం

## గ్లోబల్ పరిశోధన మరియు ప్రతిభాభివృద్ధికి ఐఐటీ హైదరాబాద్ మిత్సుబిషి ఎలక్ట్రిక్ ఒప్పందం

సంగారెడ్డి జిల్లా, ప్రతినిధి.ఫిబ్రవరి 13 గాండీవం :

ఇండియన్ ఇన్‌స్టిట్యూట్ ఆఫ్ టెక్నాలజీ హైదరాబాద్ (ఐ ఐ టి ఎచ్ ) జపాన్‌కు చెందిన మిత్సుబిషి ఎలక్ట్రిక్ కార్పొరేషన్‌తో మూడు సంవత్సరాల వ్యూహాత్మక అవగాహన ఒప్పందం (యం ఓ యు) కుదుర్చుకుంది. 2026 ఫిబ్రవరి నుంచి 2029 ఫిబ్రవరి వరకు అమల్లో ఉండే ఈ ఒప్పందం ద్వారా పరిశ్రమ--విద్యా సంస్థల మధ్య సహకారం మరింత బలోపేతం కానుంది. ఈ భాగస్వామ్యం కింద కృత్రిమ మేధస్సు (ఏ-1), క్వాంటమ్ టెక్నాలజీస్, సైబర్ సెక్యూరిటీ, స్మార్ట్ మొబిలిటీ వంటి భవిష్యత్ సాంకేతిక రంగాల్లో సంయుక్త పరిశోధనలు చేపట్టనున్నారు. విద్యార్థుల ఇంటర్న్‌షిప్‌లు, పరిశోధకుల మార్పిడి కార్యక్రమాలు, సంయుక్త ప్రచురణలు, వర్క్‌షాప్‌లు, హ్యాకథాన్‌లు నిర్వహించడం ద్వారా గ్లోబల్ ర్ ఒ డీ అనుభవాన్ని కల్పించనున్నారు. ఇప్పటికే ఐఐటీ హైదరాబాద్‌లో ఉన్న టెక్నాలజీ ఇన్నోవేషన్ హబ్ ఆన్ అటోనమస్ నావిగేషన్ (టి ఐ ఎచ్ ఏ ఎన్) ద్వారా మిత్సుబిషి ఎలక్ట్రిక్‌తో సహకారం కొనసాగుతోంది. ఈ కొత్త ఒప్పందం ఆ సహకారాన్ని మరింత విస్తరించనుంది. ఐఐటీ హైదరాబాద్ డైరెక్టర్ ప్రొఫెసర్ బి.ఎస్. మూర్తి మాట్లాడుతూ, ఈ భాగస్వామ్యం ఆధునిక సాంకేతికతల అభివృద్ధికి తోడ్పడటమే కాకుండా, పరిశోధన ఫలితాలను సమాజానికి ఉపయోగపడే విధంగా మలచడంలో కీలక పాత్ర పోషిస్తుందని తెలిపారు. మిత్సుబిషి ఎలక్ట్రిక్ గ్లోబల్ ర్ ఒడీ వ్యూహానికి అనుగుణంగా, ఈ ఒప్పందం ద్వారా దీర్ఘకాలిక సాంకేతిక పరిష్కారాలు అభివృద్ధి చేయడమే లక్ష్యమని సంస్థ ప్రతినిధులు తెలిపారు. ఈ ఒప్పందంతో ఐఐటీ హైదరాబాద్ అంతర్జాతీయ స్థాయిలో పరిశోధన మరియు పరిశ్రమ భాగస్వామ్యంలో తన స్థానాన్ని మరింత బలపరుచుకుంది.

**ఐఐటీ హైదరాబాద్ గురించి:**
2008లో స్థాపించబడిన ఐఐటీ హైదరాబాద్, విద్యా, పరిశోధన, స్టార్టప్ రంగాల్లో వేగంగా ఎదుగుతున్న ప్రముఖ సాంకేతిక విద్యాసంస్థ. యన్ ఐ ర్ యఫ్ -2025 ర్యాంకింగ్స్‌లో 7వ స్థానంలో నిలిచిన ఈ సంస్థ, ఆవిష్కరణల్లో దేశవ్యాప్తంగా ప్రత్యేక గుర్తింపు పొందింది. 340కి పైగా అధ్యాపకులు, 5,800కి పైగా విద్యార్థులతో, వేలాది పరిశోధనా ప్రాజెక్టులు, పేటెంట్లు, స్టార్టప్‌ల ద్వారా దేశ అభివృద్ధికి తోడ్పడుతోంది.

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గాండీవం

## ఐఐటి హైదరాబాద్ ఏన్ జెన్ తపాలా కార్యాలయాన్ని సందర్శించిన ప్రొబేషనరీ అధికారుల బృందం

సంగారెడ్డి జిల్లా ప్రతినిధి.ఫిబ్రవరి 12 గాండీవం :

సంగారెడ్డి జిల్లా కంది సమీపంలోని ఐఐటీ హైదరాబాద్ ప్రాంగణంలోని ఏంజెన్ తపాలా కార్యాలయాన్ని ఇండియన్ పోస్టల్ సర్వీస్కు చెందిన తొమ్మిది మంది ప్రొఫెషనరీ అధికారుల ప్రతినిధి బృందం సందర్శించారు. వీరిలో ఏడుగురు భారతదేశం నుండి కాగా ఇద్దరు భూటాన్ రాయల్ గవర్నమెంట్ నుండి రావడం జరిగింది. ఏంజెల్ తపాలా కార్యాలయం ఆధునిక యుగానికి తగిన విధంగా సాంప్రదాయ తపాలా అనుభవాన్ని కొత్తగా నిర్వచించాలని వారసత్వాన్ని ఆధునిక సాంకేతికత సమన్వయం చేసేందుకు ఐఐటీ హైదరాబాద్ డిజైన్ బృందాన్ని ప్రశంసించారు. వీటిలో వాస్తు శిల్ప సమన్వయం, కళాత్మక ప్రేరణ, సహకార ఆవిష్కరణ, అంశాలను నిశితంగా పరిశీలించి తెలుసుకున్నారు. కార్యక్రమంలో పోస్టల్ శాఖ ఉన్నతాధికారులు ప్రతినిధుల బృందం సభ్యులు తదితరులు పాల్గొన్నారు.

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ABN ఆంధ్రజ్యోతి

## ఘనంగా ఇండస్ట్రీ సమ్మిట్–2026

సమ్మిట్‌లో వివిధ పరిశ్రమల ప్రతినిధులు, ఐఐటీహెచ్ పరిశోధకులు

కంది, మార్చి 3 (ఆంధ్రజ్యోతి): దేశాభివృద్ధిలో పరిశోధనలకు పారిశ్రామిక అండ కల్పించడమే లక్ష్యంగా సంగారెడ్డి జిల్లా కందిలోని ఐఐటీ హైదరాబాద్‌లో కెమికల్ ఇంజినీరింగ్ విభాగం తొలి ఇండస్ట్రీ సమ్మిట్-2026ను మంగళవారం ఘనంగా నిర్వహించింది. చమురు, ఇంధనం, ఔషధ రంగాలు సహా సుమారు 40 ప్రముఖ పరిశ్రమల నుంచి దాదాపు వంద మంది ప్రతినిధులు ఈ సదస్సుకు హాజరయ్యారు. పోస్టర్ ప్రెజెంటేషన్లు, ల్యాబ్ సందర్శనల ద్వారా పరిశ్రమ ప్రతినిధులు, పరిశోధకులు నేరుగా తమ ఆలోచనలను పంచుకున్నారు. కోల్ ఇండియా టెక్నికల్ డైరెక్టర్ అచ్యుత ఘటక్ మాట్లాడుతూ విద్యాసంస్థలు, పరిశ్రమల మధ్య నమ్మకంతో కూడిన దీర్ఘకాలిక భాగస్వామ్యాలే దేశ వృద్ధికి దోహదపడతాయి. ఐఐటీహెచ్ డైరెక్టర్ ప్రొఫెసర్ బీ.ఎస్. మూర్తి వీడియో కాన్ఫరెన్స్ ద్వారా ప్రసంగిస్తూ.. పరిశోధనలు జాతీయ పారిశ్రామిక అవసరాలకు అనుగుణంగా ఉండాలి. పరిశ్రమలు కేవలం నిధులు ఇవ్వడమే కాకుండా, సమస్యల గుర్తింపులోనూ, మెంటర్ షిప్‌లోనూ భాగస్వాములు కావాలన్నారు. కెమికల్ ఇంజినీరింగ్ విభాగాధిపతి ప్రొఫెసర్ చంద్రశేఖర్ శర్మ మాట్లాడుతూ ఏటా ఇలాంటి సదస్సులు నిర్వహించి పరిశ్రమలతో నిరంతర అనుసంధానాన్ని కొనసాగిస్తామన్నారు.


## ఐఐటీ హైదరాబాద్‌లో 'సండేస్ ఆన్ సైకిల్'కు విశేష స్పందన

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## ఐఐటీహెచ్‌లో సందడిగా 'సండే ఆన్ సైక్లింగ్'


## ఐఐటీ హైదరాబాద్‌లో ముగిసిన జాతీయ ఆరోగ్య క్లెయిమ్‌ల సదస్సు


## ఐఐటీహెచ్‌లో మోదుగ పూల సోయగం


## ఐఐటీ హైదరాబాద్‌లో హెల్త్ క్లెయిమ్ హ్యాకథాన్

### బీమా ప్రక్రియలో డిజిటల్ సంస్కరణలే లక్ష్యం

చర్చలో ఐఆర్డీఏఐ ఛైర్మన్ అజయ్‌సేథ్, ఎన్‌హెచ్‌ఏ సీఈవో సునీల్‌కుమార్

కంది, మార్చి 6 (ఆంధ్రజ్యోతి) : ఆరోగ్య బీమా క్లెయిమ్స్ వ్యవస్థను సాంకేతికంగా బలోపేతం చేసే దిశగా సంగారెడ్డి జిల్లా కందిలోని ఐఐటీ హైదరాబాద్‌లో 'నేషనల్ హెల్త్ క్లెయిమ్ ఎక్స్ఛేంజ్ ఇన్నోవేషన్ మీట్ శుక్రవారం ప్రారంభమైంది. ఆయుష్మాన్ భారత్ డిజిటల్ మిషన్ కింద బీమా క్లెయిమ్స్ ప్రక్రియలో పారదర్శకత, వేగాన్ని పెంచే లక్ష్యంతో ఐదు అంశాల్లో శనివారం హ్యాకథాన్ నిర్వహించనున్నారు. ఈ పోటీల్లో హెల్త్-టెక్ స్టార్టప్‌లు, బీమా సంస్థలు, విద్యాసంస్థలు, సాఫ్ట్‌వేర్ డెవలపర్లు పాల్గొని క్లినికల్ డాక్యుమెంట్లను డిజిటలైజ్ చేయడం, క్లెయిమ్స్ దుర్వినియోగాన్ని గుర్తించడం, ఖర్చును తగ్గించే మోడళ్లపై చర్చించనున్నారు. ఇన్నోవేషన్ మీట్‌లో ఐఆర్‌డీఏఐ ఛైర్మన్ అజయ్ సేథ్, ఎన్‌హెచ్‌ఏ సీఈవో సునీల్‌కుమార్ తదితరులు పాల్గొని ఆరోగ్య బీమా రంగంలో రాబోయే మార్పులపై అభిప్రాయాలను పంచుకున్నారు.


## ఐఐటీ హైదరాబాద్‌లో ఐడీల్ 2026 సదస్సు విజయవంతంగా ముగింపు..

### అందుబాటులో ఉండే, సమగ్ర డిజిటల్ లైబ్రరీల నిర్మాణంపై జాతీయ స్థాయి చర్చలు

సంగారెడ్డి జిల్లా, ప్రతినిధి,మార్చి 10 గాండీవం :

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మన మహతి న్యూస్
తెలుగు దిన పత్రిక
2026-03-14
https://epaper.manamahatinews.com/

# ఐఐటీ హైదరాబాద్‌లో కెమికల్ ఇంజినీరింగ్‌లో రెండు కొత్త ఎం.టెక్ కోర్సులు.

సంగారెడ్డి, మార్చ్ 13,మన మహతి న్యూస్ : ఆధునిక పరిశ్రమల అవసరాలను దృష్టిలో పెట్టుకుని ఇండియన్ ఇన్స్టిట్యూట్ ఆఫ్ టెక్నాలజీ హైదరాబాద్ ([illegible]) లోని కెమికల్ ఇంజినీరింగ్ విభాగం రెండు కొత్త అత్యాధునిక పీజీ ప్రోగ్రామ్‌లను ప్రారంభించింది. డిజిటల్ మరియు కంప్యూటేషనల్ రంగాల్లో వేగంగా జరుగుతున్న మార్పులకు అనుగుణంగా ఇంజినీర్లను సిద్ధం చేయడం లక్ష్యంగా ఈ కోర్సులను ప్రవేశపెట్టింది.ప్రారంభించిన కోర్సులు ఎం.టెక్ ఇన్ [illegible] ఇన్ కెమికల్ ఇంజినీరింగ్ మరియు ఎం.టెక్ ఇన్ కంప్యూటేషనల్ కెమికల్ ఇంజినీరింగ్[illegible] తో కెమికల్ ఇంజినీరింగ్ఎం.టెక్ ఇన్ [illegible] ఇన్ కెమికల్ ఇంజినీరింగ్ కోర్సు ద్వారా కెమికల్ ఇంజినీరింగ్ ప్రాథమిక సూత్రాలను ఆర్టిఫిషియల్ ఇంటెలిజెన్స్, మెషిన్ లెర్నింగ్ మరియు డేటా ఆధారిత మోడలింగ్‌తో సమన్వయం చేస్తారు. ఈ కోర్సులో భాగంగా విద్యార్థులు ప్రాసెస్ ఆప్టిమైజేషన్, మెటీరియల్స్ డిస్కవరీ, రియాక్షన్ ఇంజినీరింగ్, స్మార్ట్ మాన్యుఫాక్చరింగ్, సస్టైనబుల్ ఎనర్జీ సిస్టమ్స్ వంటి రంగాల్లో ఆధునిక అల్గోరిథమ్‌లు మరియు విశ్లేషణా పద్ధతులను ఉపయోగించడం నేర్చుకుంటారు.కంప్యూటేషనల్ కెమికల్ ఇంజినీరింగ్ఎం.టెక్ ఇన్ కంప్యూటేషనల్ కెమికల్ ఇంజినీరింగ్ కోర్సు సంక్లిష్టమైన కెమికల్ ప్రక్రియల మల్టీస్కేల్ మోడలింగ్ మరియు సిమ్యులేషన్‌పై దృష్టి సారిస్తుంది. ఈ కోర్సులో కెమికల్ ఇంజినీరింగ్, గణితం మరియు కంప్యూటింగ్ అంశాలను సమన్వయం చేస్తూ కంప్యూటేషనల్ థర్మోడైనమిక్స్, కంప్యూటేషనల్ ఫ్లూయిడ్ డైనమిక్స్, మాలిక్యులర్ మోడలింగ్, రియాక్షన్ మోడలింగ్, న్యూమరికల్ ఆప్టిమైజేషన్ వంటి అంశాలను బోధిస్తారు.

ఈ రెండు ప్రోగ్రామ్‌లలో పరిశోధన, ప్రాక్టికల్ కంప్యూటేషనల్

శిక్షణ మరియు పరిశ్రమలతో పరస్పర చర్యకు ప్రత్యేక ప్రాధాన్యత ఇవ్వనున్నారు. ఈ కోర్సులను పూర్తి చేసిన విద్యార్థులకు కెమికల్స్, ఫార్మాస్యూటికల్స్, ఎనర్జీ, అడ్వాన్స్‌డ్ మెటీరియల్స్ మరియు డిజిటల్ మాన్యుఫాక్చరింగ్ వంటి రంగాల్లో మంచి కెరీర్ అవకాశాలు లభించే అవకాశముందని సంస్థ వెల్లడించింది.

నవతెలంగాణ

# ఇంజనీరింగ్ భవిష్యత్తు డొమైన్ నైపుణ్యం, డిజిటల్ ఇంటెలిజెన్స్

- ఐఐటీహెచ్ డైరెక్టర్ ప్రొఫెసర్ బి.ఎస్. మూర్తి

నవతెలంగాణ-కంది

ఇంజనీరింగ్ భవిష్యత్తు డొమైన్ నైపుణ్యం ,డిజిటల్ ఇంటెలిజెన్స్ ఖండన వద్ద ఉందని ఐఐటీహెచ్ డైరెక్టర్ ప్రొఫెసర్ బి.ఎస్. మూర్తి అన్నారు. శుక్రవారం మండల కేంద్రంలోని ఐఐటీహెచ్‌లో కెమికల్ ఇంజనీరింగ్ కోసం AI/ML లో MTech, కంప్యూటేషనల్ కెమికల్ ఇంజనీరింగ్ ప్రోగ్రామ్‌ను ప్రారంభించారు. ఈ సందర్భంగా ఆయన మాట్లాడుతూ.. ఆధునిక ప్రాసెస్ పరిశ్రమల కోసం AI, డేటా సైన్స్, అధునాతన కంప్యూటేషనల్ మోడలింగ్‌లో నైపుణ్యాలతో ఇంజనీర్లను సన్నద్ధం చేయడం ప్రోగ్రామ్‌ల లక్ష్యమన్నారు. పాఠ్యాంశాలు కెమికల్ ఇంజనీరింగ్ ఫండమెంటల్స్‌ను మెషిన్ లెర్నింగ్, సిమ్యులేషన్స్ , డేటా-ఆధారిత ఇంజనీరింగ్‌తో మిళితం చేస్తాయని తెలిపారు. నేడు ఇంజనీరింగ్ ఆవిష్కరణలు డేటా, కంప్యూటేషన్, ఇంటెలిజెంట్ సిస్టమ్‌ల ద్వారా ఎక్కువగా నడపబడుతున్నాయని తెలిపారు. కెమికల్ ఇంజనీరింగ్ విభాగం అధిపతి ప్రొఫెసర్ చంద్ర శేఖర్ శర్మ మాట్లాడుతూ.. ఆర్టిఫిషియల్ ఇంటెలిజెన్స్, అడ్వాన్స్‌డ్ సిమ్యులేషన్స్, డేటా-ఆధారిత నిర్ణయం తీసుకోవడం ఏకీకరణతో కెమికల్ ఇంజనీరింగ్ వేగంగా అభివృద్ధి చెందుతోందన్నారు. రెండు ప్రోగ్రామ్‌లకు అడ్మిషన్లు రాబోయే విద్యా సంవత్సరంలో ప్రారంభమవుతాయని , కఠినమైన కోర్సు పనిని పరిశ్రమ బహిర్గతం , పరిశోధన-ఆధారిత థీసిస్ పనితో మిళితం చేస్తాయన్నారు. ఇందులో విద్యా మంత్రిత్వ శాఖ సీట్లకు గేట్ ఆధారిత ఎంపిక, అదనపు స్వీయ-ప్రాయోజిత సీట్లు ఉంటాయన్నారు.

ఈనాడు
epaper.eenadu.net



# ఐఐటీహెచ్‌కి వెళ్తే.. మన ఘన చరితనీ చూడండి

ప్రాచీన కళలు, చారిత్రక కట్టడాలను సరికొత్త సాంకేతికతతో డిజిటల్ రూపంలో భద్రపరుస్తోంది ఐఐటీ హైదరాబాద్. కేంద్ర ప్రభుత్వం దేశవ్యాప్తంగా ఉన్న 80 డిజైన్ ఇన్నోవేషన్ కేంద్రాల (డీఐసీ)కు ఈ బాధ్యతలు అప్పగించగా.. వీటికి ఐఐటీహెచ్‌లోని డీఐసీ నోడల్ కేంద్రంగా వ్యవహరిస్తోంది. ఇందులో భాగంగా తెలంగాణ, తమిళనాడులోని చారిత్రక కట్టడాలు, జానపద, ప్రాచీన కళలు, ఆచారాలు, పండుగలను ఐఐటీహెచ్ రెండేళ్లుగా డిజిటలైజేషన్ చేస్తోంది. ఇందుకోసం ఇక్కడి డీఐసీలో వీఆర్ఎల్ (వర్చువల్ రియాల్టీ ల్యాబ్)ను ఏర్పాటుచేశారు. డీఐసీ విభాగాధిపతి దీపక్ జాన్ మాథ్యూ ఆధ్వర్యంలో పీహెచ్‌డీ, ఐఐటీహెచ్ విద్యార్థులు ఇందులో భాగస్వాములయ్యారు. చారిత్రక కట్టడాలను త్రీడీ, లైడార్ పరికరాలను వినియోగించి డిజిటలైజ్ చేస్తున్నారు. ఇప్పటికే రామప్ప, ఖిలా వరంగల్, మెదక్ చర్చి, మెదక్ ఖిల్లా వంటివాటిని డిజిటల్‌గా నిక్షిప్తం చేశారు. కుతుబ్‌షాహీల కాలం నాటి మౌఖిక చరిత్రను 360 డిగ్రీల వర్చువల్ రియాలిటీ యానిమేషన్ ద్వారా భద్రపరుస్తున్నారు. నిర్మల్ పెయింటింగ్స్, నకాషీ చిత్రాలు, వెండితీగలతో చేసే కరీంనగర్ సిల్వర్ ఫిలిగ్రీ, పోచంపల్లి ఇక్కత్, గద్వాల, నారాయణపేట చేనేత చీరల తయారీ వంటివీ ఈ జాబితాలో ఉన్నాయి. తమిళనాడులోని దేవాలయాలను చిత్రీకరించేందుకు ఏడాదిపాటు పనిచేసినట్లు ఓ విద్యార్థి తెలిపారు. ఆదిలాబాద్ జిల్లా ఉట్నూర్‌లోని గిరిజన తెగ ఓజా ఆచార వ్యవహారాలను నిక్షిప్తం చేసేందుకు 8 నెలలు తండాల్లోనే నివాసం ఉన్నట్లు మరో విద్యార్థి వెల్లడించారు. ఓజా గిరిజనులు రాగి, ఇత్తడిని వినియోగించి విభిన్న కళాకృతులను తయారు చేయడంలో ఖ్యాతి గడించారు. తమ వీఆర్ ల్యాబ్‌లో వీఆర్ గ్లాసెస్ ధరించి ఈ వీడియోలను చూస్తే ప్రత్యక్షంగా ఆయా చారిత్రక కట్టడాలను చూసిన అనుభూతి కలుగుతుందని జాన్ మాథ్యూ చెప్పారు. - ఈనాడు, సంగారెడ్డి

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# T universities make modest gains in QS rankings by Subject

TIMES NEWS NETWORK

Hyderabad: Universities from Telangana have registered a modest presence in the QS World University Rankings by Subject 2026, with a few institutions featuring across select disciplines.

The Indian Institute of Technology, Hyderabad saw an improvement in engineering & technology, moving up to 395 globally from the 501-550 band in 2025. The institute is now ranked across nine subjects, with key engineering disciplines such as mechanical, electrical & electronic, and chemical engineering placed in the 251-300 range. Other areas, including computer science, physics, and materials science, also feature.

The University of Hyderabad continues to feature in seven subjects across humanities, social sciences, and natural sciences, including linguistics, english language & literature, sociology, political science, chemistry, economics & econometrics, and biological sciences, mostly in mid-to-lower global bands. Notably, performing arts dropped out in 2026, while economics & econometrics was added.

The English and Foreign Languages University features in two arts & humanities subjects — linguistics and english language & literature — after being absent last year.

IITH SEES IMPROVEMENT

## IITH inaugurated Innovation Day & the Inter-IIT UG Innovation Meet 2026, uniting young innovators from across IITs to showcase solutions to real-world challenges

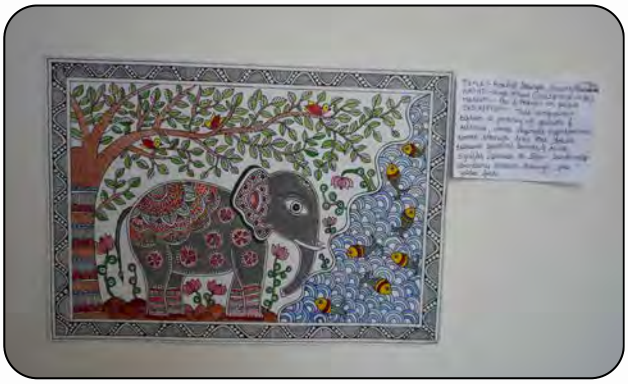

## The IndiaAI Mission, MeitY, in collaboration with IITH, inaugurated the "Conclave on Inclusion for Social Empowerment", marking a key milestone towards the India AI Impact Summit 2026






## IITH celebrated the 77th Republic Day of India with pride and patriotism


## The Department of Liberal Arts celebrated Department Day with engaging discussions on humanities and social sciences



## The NSS, IITH, marked Run for Swadeshi, uniting the campus community to celebrate Swadeshi values, youth spirit, and nation building


## Over 1000 Ride at IIT Hyderabad's 'Sundays on Cycle' Under Fit India Initiative



## Universal Design Exhibition by B.Des Second Year students at the Department of Design successfully showcased inclusive, user-centric innovations and creative solutions.


## The trainee officers of Indian Postal Service (IPoS) visited IIT Hyderabad inspired with valuable insights on research, technology, and public service

## IITH inaugurated the N-Gen Post Office, enhancing campus services with faster, smarter, and digitally enabled postal facilities



## The Knowledge Resource Centre, IITH, kicked off the Annual Book Fair 2026 with a vibrant celebration of books, learning, and reading culture

## The inaugural concert of the Centre for Creative Arts at IITH featured the rhythmic brilliance of Prof. Yella Venkateshwara Rao (Padma Shri) on the Mridangam

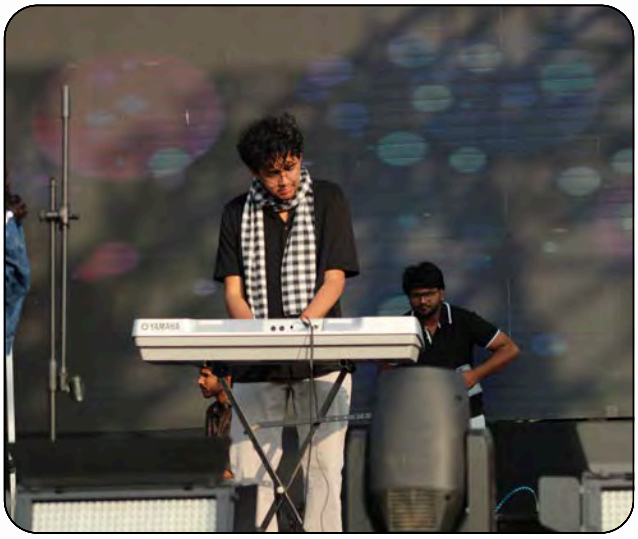

## SPIC MACAY IIT Hyderabad, in collaboration with CCA, successfully hosted a soulful evening of Dhrupad by Ustad F. Wasifuddin Dagar, accompanied by Mohan Shyam Sharma.

## Laura Williams visited IITH, strengthening academic and international collaboration ties



## Elan & nVision 2026, South India's largest student-run techno-cultural fest, was inaugurated at IITH


# Elan & nVision 2026, South India's largest student-run techno-cultural fest, celebrating technology, innovation, and culture at a grand scale

## IITH EBSB organized vibrant Makar Sankranti celebrations featuring kite flying, Rangoli, a bonfire, mini games, and an energetic shuffle dance performance



## IITH students came together to celebrate Holi with vibrant colors, joy, and festive spirit across campus

## Mehfil — an evocative evening of shayaris and nazms, where emotions turn into words, as RDM and Irshaad in collaboration with Diesta create an experience to be felt beyond just heard

## Diesta '26 at the IITH brought together students across departments to celebrate sports, culture, and the vibrant spirit of campus life

## India's first ever "Inter IIT UG Innovation Meet RISE2026 organised at IITH—celebrating young innovators shaping India's future


## IIT Hyderabad inaugurates India's first bioengineering-led Centre of Excellence for Lung Health in collaboration with ILH and Justus Liebig University, Giessen, Germany


## The Centre of Design Excellence (CoDE), IITH, inaugurated the CoDE Studio — a state-of-the-art facility to advance design-led innovation, skill development, and entrepreneurship

## A decade celebrated with memories and milestones as the Class of 2015 reunited at IITH for Annual Alumni Day 2025



## The Class of 2014 leaves a lasting legacy at IITH with the inauguration of the PR Studio during Annual Alumni Day 2025 and Decennial Celebrations

## IITH Launches Podcast Series with Director Prof B. S. Murty on Innovation and the Future of Technology

## IITH, Department of Computer Science & Engineering hosted ACM ARCS 2026 alongside the ACM India Annual Event, bringing together PhD scholars nationwide to present research, share insights, and engage with leading experts


## Women's Day at IITH brought together voices of empowerment through insightful talks and vibrant cultural performances

On the occasion of International Women's Day, the Sports Department at IITH successfully organized sports events celebrating the strength, fitness, and achievements of women across campus

## IITH Volleyball Teams showcased exceptional talent & won the Infinity Cup hosted by Woxsen University

## The "Introduction to Dhrupad" course under Open to All Teaching (OAT) by IITH, led by Ustad Wasifuddin Dagar, concluded successfully, offering participants a rich immersion into the timeless art of Dhrupad

## The Department of Liberal Arts presented a captivating drama performance, showcasing the creativity and talent of its students

## IITH reaffirmed its commitment to democracy by organizing the Voters Pledge, inspiring the campus community to vote responsibly and uphold democratic values

## AIChEmEx 2026 successfully concluded as a vibrant two-day celebration of innovation, collaboration, and excellence in chemical engineering at IITH

## IITH celebrated New Year 2026 with a joyful family get-together, bringing faculty and staff together in the spirit of togetherness and celebration

## Students from different schools visited IITH exploring the campus and gaining insights into academic life and research activities uner "Visit IITH"







## IITH Successfully conducted Plantation Drives

Plantation Drive for the month of January

Plantation Drive for the month of February

Plantation Drive for the month of March

## IITH recorded 27 bird species during the Global Campus Bird Count on 14 February, showcasing the rich biodiversity on campus

## Come spring, the vibrant blooms of Butea monosperma set the landscape in and around IIT Hyderabad ablaze with color

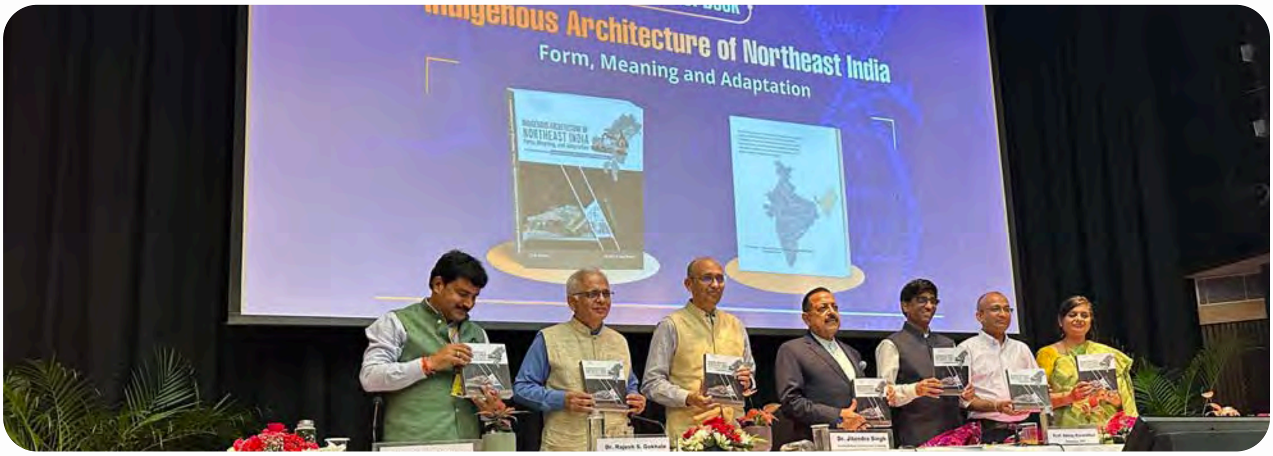





## IITH Successfully Organized AIDL–2026: A Symposium on Accessible and Inclusive Digital Libraries



## IITH Book on Indigenous Architecture Inaugurated at Indian National Science Academy on National Science Day




## Office of Career Services Fair 2026 at IIT Hyderabad connected students with diverse career opportunities and industry insights.

## Industry Summit 2026 at IITH brought together 100+ industry leaders to advance meaningful industry–academia collaboration



## The Department of Materials Science and Metallurgical Engineering at IITH celebrated IIM's 80th Foundation Day and National Metallurgists' Day with the inaugural Prof. P. Rama Rao Distinguished Lecture by Prof. Shrikant Lele on Computational Thermodynamics of Alloys

## MSME Tech Connect 2026 commenced at IITH under the MSME-SCIP Programme, uniting innovators, industry leaders, investors, and policymakers to accelerate technology transfer, IPR excellence, and MSME-driven innovation





## The Technology Exhibition at MSME Tech Connect 2026 showcased cutting-edge innovations across AI, Robotics, CleanTech, and HealthTech at IITH, enabling MSMEs to explore commercialization, scaling partnerships, and IP support opportunities

## The One-Day Welding Research Scholars Symposium at IITH under the Indian Institute of Welding (Hyderabad Chapter), was successfully concluded

## IITH hosts First-of-Its-Kind UKRI International Symposium

## IITH hosted SiMBio2026, an international conference and workshop on Single-Molecule Biophysics, featuring expert talks, discussions, and hands-on training in advanced imaging technologies

## The IKS–Students Chapter inauguration was a significant academic and cultural initiative that fostered awareness and engagement with Indian Knowledge Systems among students and faculty


## The Extra Mural Lecture on “AI Technologies and the Future of Work and Workers” by Dr. Pramod Khargonekar (UC Irvine) was successfully held at IIT Hyderabad, featuring engaging participation and insightful discussions

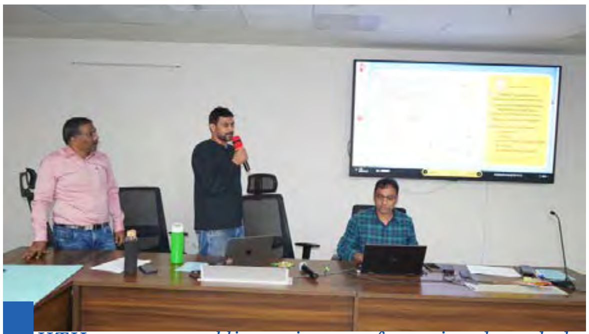

## Extra Mural Lecture on “How to Fail Successfully?” by Jayneel Trivedi inspires a new perspective on embracing failure for success



## As part of E-Summit '26, E-Cell IIT Hyderabad presents Fetching Fortunes—a high-stakes live startup pitching event where innovative ventures compete for a ₹10,00,000 prize pool before top investors

## The Kyushu University Forum (KYUDAI NOW) at IITH marked a step forward in India–Japan academic and research collaboration


*IIT Hyderabad hosted Prof. H. C. Verma during SIPPEW 2026, bringing together PGT physics teachers for an enriching learning experience*



*IITH empowers public service transformation through the Rashtriya Karmayogi Master Trainer's Training Programme*

*A three-day workshop on Technological Advancements in Healthcare Research was inaugurated at IITH under the ANRF-PAIR (PRATHAME) programme, fostering interdisciplinary collaboration*

*The ANRF-PAIR Workshop on Advanced Materials at IITH focused on next-generation materials research, spanning AI-driven design, nanofabrication, and advanced characterization*


*Session on"Building and Scaling Social Ventures" by Ms. Vasanta Chigurupati Founder & CEO of TheOneShop.in*

*Session on"Models for Retail Supply Chain and Diagnosis for Infrastructure" by Prof. Vittal Prabhu, Professor and Charles & Enid Schneider Faculty Chair*


*IITH successfully organized the international conference "Symposium on Magnetism and Spintronics (SMS-3)", bringing together global experts to share advances in magnetism and spintronics*

*Session on "Execution Under Constraint: Design,Evidence, Regulation,Trust, and Market Access in Medical Devices"by Mr. Yuvateja Thotamalla, Global Executive Manager*

*Session on "There is No Shortcut to Success" by Mr. P. Rama Kanth, Managing Director and CEO, eSoft Consulting Ltd*

*Session on "The Impetus of Taxation system to Startups in India" and "The current landscape of FDA-approved AI/ML medical devices" by Mr. Krishna Koundinya, Joint Commissioner, Hyderabad CGST & Customs*

*GDC I-NITIATE Cohort marks the beginning of an exciting journey of innovation, mentorship, and entrepreneurial growth for emerging changemakers*

*Successfully hosted the 2nd ANRF Prime Minister Early Career Research Grant (PMECRG) Meeting at IIT Hyderabad, bringing together 140+ experts to evaluate nearly 3,400 proposals and strengthen India's early-career research ecosystem through rigorous and collaborative review*


*Talk by Prof. Sandeep K. Shukla, Director IIIT Hyderabad on"Securing the Frontier: Navigating Threats and Governance in the Age of Generative and Agentic AI*

*Workshop on "Precision Medicine and Clinical AI: Laboratory Innovation to Bedside Application" was successfully held at IITH as part of the AI Impact Summit 2026*


*NHA Concludes Two-Day NHCX Innovation Meet in IIT Hyderabad; Finalists of NHCX Hackathon Showcase Winning Solutions*

*The first cohort of the "Driving Organisational Effectiveness through Employee Experience" workshop at IIT Hyderabad (DSSI Studios, Department of Design) concluded successfully on 28th March*

*IIT Hyderabad participated in the FWIP Kick-Off Symposium (2026) at Ochanomizu University, Tokyo, fostering global academic collaboration*

*The Centre for Public Humanities at IIT Hyderabad organized a workshop on "Gender in Academia: Research, Practice, and Safety in the Workplace"*

*The Department of Liberal Arts, in collaboration with Alliance Française Hyderabad, successfully hosted a film screening and discussion of I Am the Future on 30th March 2026.*

## Collaborations

*IIT Hyderabad strengthens global academic ties by partnering with the University at Albany (SUNY) to advance collaborative research, learning, and innovation*

*IITH and Mitsubishi Electric Partner to Advance Global Research and Talent Development*

### Prof. Mahendrakumar Madhavan,
Department of Civil EngineeringDirector

*Awarded The Prestigious Fellowship of the Institution of Structural Engineers IStructE*

### Prof. Shekhar Mande
Distinguished Professor, IIT Hyderabad

*Appointed As President of the Indian National Science Academy (INSA)*

### Prof. Vandana Sharma
Department of Physics

*Selected The prestigious IEEE India Council Award – Woman Technologist of the Year 2025*

### Dr. Sk Zeeshan Ali
Department of Civil Engineering

*Awarded the Associateship of the Indian Academy of Sciences, Bengaluru, for the year 2026*

### Prof. Sushmee Badhulika
Department of Electrical Engineering

*Received The prestigious VASVIK (Vividhlaxi Audyogik Samshodhan Vikas Kendra) Industrial Research Award for the year 2025 in the category of Electrical & Electronic Sciences & Technology*

### Prof. Sai Santosh Kumar Raavi
Department of Physics

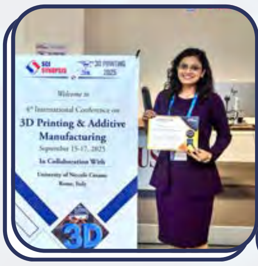
*Appointed as an Editorial Advisory Board of APL Engineering Physics (AIP Publishers)*

### Dr. Nithyanandan Kanagaraj
Department of Physics

*Appointed as an Assistant Editor of the prestigious Journal OPITCA Photonic Research*

### Ms. Priyanku Nath
Department of Chemistry

*Received The Best Poster Presentation Award and a Cash Prize Award, at the 18th International Conference on Polymer Science and Technology (SPSI-MACRO 2025)*



### Ms. Bhagyshree Khandare
PhD Scholar, Department of Civil Engineering

*Conferred with the "Best Oral Presenter" award at the 4th International Conference on 3D Printing and Additive Manufacturing (3D Printing 2025)*

### Ms. Bhuvana Priya
PhD scholar, Department Civil Engineering

*Received Best Poster Award at the Conference of Transportation Research Group of India (CTRG 2025)*

### Ds. Suman Yadav
Research Scholar, Department of Chemistry

*Received Best Poster presentation Award and a cash prize of 100 Euros at the International Meeting of the Battery Research Society (IMBRS 2025)*

### Mr M. Bobby Barnabas
Research Scholar, Department of Chemistry

*Received The Nanoscale Advances Poster Presentation award at the 3rd International conference in Nanoscience and Nanotechnology (ICNAN-2025)*


### Mr. Deewan Singh Teja
**Research Scholar, Department of Chemistry**

*Received The Best Poster Prize at the Theoretical Chemistry Symposium (TCS-2025)*

### Mr Rudresh K
**PhD Scholar, Department of Physics**

*Received the Best Presenter Award at the 2nd International Conference on Sustainable Science and Technology for Tomorrow (SciTech 2025)*

### Ms. Priyanka Dewangan,
**PhD Scholar, Department of Physics**

*Received The Best Poster Presentation Award in XXIII International Workshop on the Physics of Semiconductor Devices 2025 (IWPSD-2025)*

### Ms. Sumona Garg
**PhD Scholar, Department of Biotechnology**

*Received Best Poster Award in"Advancing food safety with smart and active food packaging using lignin/chitosan hydrogels" at (X SEEC), 2025*

### Mr. Mokilla Ramachandra Reddy,
**PhD Scholar, Department of Chemistry**

*Received The Best Poster Prize at the Professor A. Srikrishna Charitable Trust Symposium on "Innovations in Natural Products and Synthetic Strategies (INPSS-2025)*

### Mr. Sai Satwik
**BTech Student, Department of Artificial Intelligence**

*Has authored a contemporary fictional novel titled"Two Places I Belong"The novel thoughtfully explores themes of gender, family, identity, and belonging, resonating with readers across diverse age groups and backgrounds*

### Ms. Neha Mishra
**Research Scholar, Department of Materials Science and Metallurgical Engineering**

*Received The Best Oral Presentation Award at the 9th International Conference on New Energy and Applications (ICNEA-2025)*

### Ms. Utkarsha Mahanta
**PhD scholar, Department of Physics**

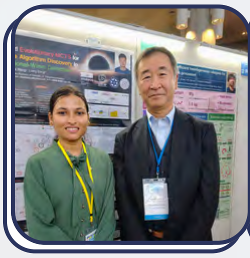
*Selected as the Carl Storm Opportunity Fellow to attend 'Sensory Transduction in Microorganisms' - Gordon Research Conference (GRC-STIM 2026) in Ventura, California, United States*


### Mr. Alekha Meher
**PhD Scholar, Department of Liberal Arts**

*ReceivedThe Best Paper Award at the International Conference on Digitalization for Inclusive Finance and Sustainability.The award carries a cash prize of INR 5,000*


### Mr. Badweeti Kasinayana
**PhD scholar, Department of Civil Engineering**

*Received The First Prize in the Student Poster Presentation in the Smart Mobility Category under the team name "Bharat ADAS Vision" at the 19th edition of the SIAT 2026*



### Ms. Manaswini Ravipati
**Phd Scholar, Department of Electrical Engineering**

*Received as one of the nine students representing India at the 17th HOPE Meeting with Nobel Laureates organized by the Japan Society for the Promotion of Science (JSPS).*

*Also, Honoured with the Unique Presentation Award during the event*

### Ms. Kadambari K B
**PhD Scholar Department of Liberal Arts**

*Selected for the Zubaan Poster Project Her poster has been chosen for the Call for Posters marking the 20th Anniversary of the Poster Women Project, organized by Zubaan in collaboration with Takshila Education Society*

### Mr. Sahil Dhiman

**Joint PhD Scholar IITH (Micro-Mechanics Lab) & Deakin Universit (Metal Additive Manufacturing Group)**

*for received multiple Awards-*

- *IIM Swarna Jayanti Endowment Fund (SJEF) Travel Award to present at AAMS2025, Switzerland*
- *Best Oral Presentation Award – IIM Annual TechnicalMeeting, IIT Hyderabad*
- *Best Paper Award – Welding Research Scholar Symposium, IITH*
- *Best Poster Award – AERES'26, IISc Bangalore*

### Ms. Sneha Joseph

**PhD Scholar, Department of Chemistry**

*Received The Best Poster Award at the ICFAST TOKYO-2026 (International Conference on Frontier Areas of Science and Technology), held at the University of Tokyo, Japan*

### Mr. Venkateshwaran G

**PhD Scholar, Department of Civil Engineering**

*Received The Jal Shakti Hackathon Award and a ₹1,00,000 prize for the pitch titled:"Hybrid Membrane for Tertiary Water and Wastewater Treatment"*

### Ms. M Saraya

**MTech Student**
**Department of Climate Change**

*Secured for the Zubaan Poster Project Her poster has been chosen for the Call for Posters marking the 20th Anniversary of the Poster Women Project, organized by Zubaan in collaboration with Takshila Education Society*

### Mr. Siva Kali Kiran

**MTech Student, Department of Civil Engineering**

*Secured for the Zubaan Poster Project Her poster has been chosen for the Call for Posters marking the 20th Anniversary of the Poster Women Project, organized by Zubaan in collaboration with Takshila Education Society*


### Ms. Jyotirekha Dutta

**Phd Scholar, Department of Chemistry**

*Received SPARC Ling Award for outstanding combined performance in Flash Talk & Poster Presentation at the SPARC Conclave 2026 Also featured in the Royal Society of Chemistry – Women's Day 2026 Special Collection*

## Faculty

Dr. Amit Barnwal has been appointed as an Assistant Professor in the Department of Material Science and Metallurgical Engineering (MSME), IIT Hyderabad. Prior to joining IITH, Dr Amit was working as a post-doctoral researcher at Chalmers University of Technology, Göteborg, Sweden. Before his post-doctoral appointment, he served as a project and research scientist at the Centre for Materials for Electronics and Technology (C-MET), Hyderabad. He has developed and upscaled (TRL-6) a patented hybrid hydrometallurgical–pyrometallurgical process for Li-ion battery recycling, which has been successfully transferred to multiple industries in India. Amit did his M Tech from Jadavpur University and obtained his PhD from IIT Roorkee. His research interests are in the fields of non-ferrous extractive metallurgy, sustainable recycling, critical metals and rare earth elements recovery, hydrometallurgy and many other

**Dr. Amit Barnwal**
*Assistant Professor*
*Department of Material Science and Metallurgical Engineering (MSME)*

## Non-Teaching Staff

Mr. Srinivasa Rao Botsa holds a B.E from Andhra University. He joined the Defence Accounts Department under the Ministry of Defence as an Auditor in June 2018 and was promoted to Senior Auditor in 2025. He brings around 8 years of experience in internal audit, audit of third-party bills, and processing of third-party claims. He has also worked in the Integrated Financial Advisor (IFA) office and has experience in auditing ECHS health claims.

**Mr. Srinivasa Rao Botsa**
*Executive Assistant*
*Stores & Purchase*

Mr. Gumma Rama Kotaiah completed his Diploma in SDEBME from the Government Institute of Electronics, Secunderabad, Telangana. He later pursued a Bachelor of Technology (B.Tech) in Electronics and Communication Engineering from Vardhaman College of Engineering, Hyderabad, Telangana. Following the completion of his academic qualifications, he began his professional career as an IT Administrator at AWOK Online Services Pvt. Ltd. He then worked as a Network Engineer at Shell Networks Pvt. Ltd. Subsequently, he served as a Senior Technician at the National Institute of Technology, Warangal (NITW). Currently, he is working as a Junior Technician at IITH

**Mr. Gumma Rama Kotaiah**
*Junior Technician*
*Computer Center*

Mrs. S. Santhi is a dedicated and experienced healthcare professional with over 14 years of service in the Armed Forces Medical Services. She is a B.Sc. Nursing graduate from Sri Ramakrishna College of Nursing, Coimbatore (Dr. M.G.R. Medical University, Chennai, India), completed in 2007. Throughout her career, she has served in various capacities across prominent military hospitals. She has gained extensive experience in handling Family Ward, Surgical Ward, Medical Ward, Gynaecology Ward, Labour Room, and Cardiac Cath Lab, assisting inmultiple procedures and critical care management.

She has held key responsibilities as Nursing Officer In-charge and has served in leadership roles such as Ward Sister, Senior Sister, and GD Matron. Her experience includes postings at Command Hospital Pune, 165 Military Hospital, Military Hospital Mhow, Base Hospital Delhi Cantt, 184 Military Hospital, and 6 Air Force Hospital. Known for her reliability, clinical competence, and leadership, she combines administrative efficiency with compassionate patient care. She is skilled in medical equipment handling, teamwork, communication, decision-making, and staff scheduling.

**Mrs. S. Santhi**
*Staff Nurse*
*IITH Hospital*

భారతీయ సాంకేతిక విజ్ఞాన సంస్థ హైదరాబాద్
भारतीय प्रौद्योगिकी संस्थान हैदराबाद
Indian Institute of Technology Hyderabad

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