PURDUE UNIVERSITY | College of Engineering

Engineering Faculty Document No.: 46-24
November 27, 2023

TO: The Engineering Faculty

FROM: College of Engineering Experiential Learning Curriculum Committee

RE: New Engineering Certificate

The Experiential Learning Curriculum Committee has approved the following new Certificate from the College of Engineering. This action is now submitted to the Engineering Faculty with a recommendation for approval.

TITLE:

Undergraduate Certificate in Quantum Information Science & Technology

DESCRIPTION:

The Certificate in Quantum Information Science & Technology (16 credits) will be open to students in all undergraduate majors interested in careers in the field of quantum information science and technology. This certificate will give undergraduate students broad technical exposure to fundamental and applied topics related to QIST and is designed to supplement the baccalaureate plans of studies in different majors, including (but not limited to) engineering, computer science, physics, chemistry, math, and technology.

RATIONALE:

The United States quantum industry urgently requires a new workforce trained in this highly multidisciplinary field of QIST. To address this need, a suite of broadly accessible courses has been selected to give undergraduate students technical exposure to topics in the areas of QIST. Students who attain this certificate will be well-positioned to advance into successful careers working in the US quantum industry or national labs or pursuing graduate studies in this field. Please see additional details in attached Certificate.

Assistant Dean for Experiential Education

Undergraduate Certificate in Quantum Information Science & Technology

Originating Unit: ELCC, Undergraduate Education

The Certificate in Quantum Information Science & Technology will be open to students in all undergraduate majors interested in careers in the field of quantum information science and technology (QIST).

Since the beginning of the 21st century, explosive advancement in the realization of quantum information technologies has occurred. These quantum information technologies provide a new way for computing, communication, and sensing to occur that has the potential to surpass the performance of any classical alternative for a growing range of applications that have significant economic and national security implications. To continue to advance these exciting quantum information technologies, the United States quantum industry urgently requires a new workforce trained in this highly multidisciplinary field. To address this need, a suite of courses has been selected to give undergraduate students broad technical exposure to topics in the areas of QIST, while emphasizing *chip-scale quantum* technologies and techniques that build on Purdue's strengths in semiconductors and microelectronics to revolutionize practical applications.

Students who complete the undergraduate certificate requirements will be eligible to receive the Certificate. Combined with their Purdue major plans of study, students who attain this certificate will be well-positioned to advance into successful careers working in the US quantum industry or national labs or pursuing graduate studies in this field.

Requirements for the Certificate (Total Minimum Credit Requirement of 16 credits)

I. One semester of *ENGR 10301: Introduction to Nano- and Quantum Technology* or a similar topical seminar (1 credit).

II. One of the following QIST introduction courses (3 – 4 credits)

- PHYS 34200 – Modern Physics
- PHYS 34400 – Introduction to Quantum Science

III. One of the following QIST fundamentals courses (1 – 3 credits)

- PHYS 36000 – Quantum Mechanics
- PHYS 46000 – Quantum Mechanics I (Honors)
- PHYS 55000 – Introduction to Quantum Mechanics
- ECE 39595 – Fundamentals of Quantum Technology
- ECE 59500 – Introduction to Quantum Science and Technology
- ECE 59500 – Applied Quantum Computing I – Fundamentals

IV. QIST Experience for Undergraduates: 1 to 6 credit hours or equivalent of

- PHYS 34000 – Modern Physics Laboratory
- Research courses including relevant independent studies and Vertically Integrated Projects (VIP) courses, or

- Full-time internship relevant to technical areas of QIST. Summer or semester-long of full-time internship, co-op, or summer undergraduate research fellowship (SURF) or similar experience is considered equivalent to 6 credit hours.

V. Remaining credit hours must come from the table of courses below that have been identified as meeting the objectives of this program.

QIST Certificate Electives *[X courses]*
CS 48300 – Introduction to the Theory of Computation
CS 58400 – Theory of Computation and Computational Complexity
CHM 37400 – Physical Chemistry II
ECE 30653 – Introduction to Nanotechnology and Quantum Science and Technology
ECE 39595 – Fundamentals of Quantum Technology
ECE 50631 – Fundamentals of Current Flow
ECE 50632 – Introduction to Quantum Transport
ECE 50633 – Boltzmann Law: Physics to Computing
ECE 55200 – Introduction to Lasers
ECE 59500 – Applied Quantum Computing I – Fundamentals
ECE 59500 – Applied Quantum Computing II – Hardware
ECE 59500 – Applied Quantum Computing III – Algorithm and Software
ECE 59500 – Semiconductor Fundamentals
ECE 59500 – Semiconductor Manufacturing
ECE 59500 – Microfabrication Fundamentals
ECE 59500 – Introduction to Electronics Packaging and Heterogeneous Integration
ME 50100 – Statistical Thermodynamics
ME 50300 – Micro-And-Nano-Scale Energy Transfer Processes
MSE 50200 – Defects in Solids
PHYS 36000 – Quantum Mechanics
PHYS 46000 – Quantum Mechanics I (Honors)
PHYS 46100 – Quantum Mechanics II (Honors)
PHYS 52600 – Quantum Computing
PHYS 54500 – Solid-State Physics
PHYS 55000 – Introduction to Quantum Mechanics

Other constraints:

- Credit from only 1 of the following courses can be applied toward the total credit requirement of this certificate: PHYS 36000, PHYS 46000, ECE 39595 (Fundamentals of Quantum Technology)