PURDUE UNIVERSITY | College of Engineering

Engineering Faculty Document No.:
90-23
January 26, 2023

TO: The Engineering Faculty

FROM: The Office of Professional Practice

RE: New Engineering Certificate

The Office of Professional Practice 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 Semiconductors and Microelectronics

DESCRIPTION:

The Certificate in Semiconductors and Microelectronics (16 credits) will be open to students in all undergraduate majors interested in careers in the field of semiconductors and microelectronics. This certificate will give undergraduate students broad technical exposure to topics in the areas of semiconductors and microelectronics and is designed to supplement the baccalaureate plans of studies in different majors, including (but not limited to) engineering, computer science, physics, chemistry, technology, and business. The U.S. semiconductor/microelectronics industry is facing an overwhelming and rapidly growing crunch for trained talent – with industry forecasts estimating the need at a minimum of 50,000 additional trained semiconductor engineers and scientists by 2030. The broad scope of the semiconductors and microelectronics industry – from materials and processing to device and integrated circuit/system design, to manufacturing, supply chains, and data analytics, to testing, qualification, packaging, and thermal management – provides exciting career opportunities for students from a wide range of disciplines.

RATIONALE:

The U.S. semiconductor/microelectronics industry is facing an overwhelming and rapidly growing crunch for trained talent – with industry forecasts estimating the need at a minimum of 50,000 additional trained semiconductor engineers and scientists by 2030. Purdue University has launched a comprehensive set of innovative, interdisciplinary degrees and credentials in semiconductors and microelectronics – the Semiconductor Degrees Program (SDP) – which will enable a quick ramp-up of skilled talent and help create the next-generation of semiconductor workforce to revitalize the American semiconductor industry. As part of the SDP, a suite of relevant courses and experiential learning opportunities have been assembled into a certificate to give undergraduate students broad technical exposure to topics in the areas of semiconductors and microelectronics. 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 semiconductor and microelectronics industries.

Director, Office of Professional Practice

Link to Curriculog entry:

https://purdue.curriculog.com/proposal:23148/form

Undergraduate Certificate in Semiconductors and Microelectronics

Originating/Sponsoring Unit: College of Engineering

The Certificate in Semiconductors and Microelectronics will be open to students in all undergraduate majors interested in careers in the field of semiconductors and microelectronics.

The U.S. semiconductor/microelectronics industry is facing an overwhelming and rapidly growing crunch for trained talent – with industry forecasts estimating the need at a minimum of 50,000 additional trained semiconductor engineers and scientists by 2030. Purdue University has answered that call, becoming the first in the country to launch a comprehensive set of innovative, interdisciplinary degrees and credentials in semiconductors and microelectronics. The Semiconductor Degrees Program (SDP), a suite of innovative **Purdue degrees and credentials**, will educate both graduate and undergraduate students, enabling a quick ramp-up of skilled talent and creating the next-generation of semiconductor workforce to revitalize the American semiconductor industry. The broad scope of the semiconductors and microelectronics industry – from materials and processing to device and integrated circuit/system design, to manufacturing, supply chains, and data analytics, to testing, qualification, packaging, and thermal management – provides exciting career opportunities for students from a wide range of disciplines.

As part of the SDP, a suite of courses has been assembled into a certificate to give undergraduate students broad technical exposure to topics in the areas of semiconductors and microelectronics. Students who complete the undergraduate certificate requirements described below, including at least 1 course from at least 2 different topic areas, 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 and impactful careers working in the US semiconductor industry or national labs.

Requirements for the Certificate

I. Take at least 9 credit hours of courses in at least two out of four technical areas:

1) Semiconductor and Microelectronic Devices
2) Semiconductor Materials, Characterization, and Processing
3) Integrated Circuit and System Design, Electronic Design Automation
4) Electronics Packaging, Heterogeneous Integration, and Thermal Management
5) Semiconductor Manufacturing and Global Supply Chain Management

Below you will find a table of courses that have been identified as meeting the objectives of this program.

II. One semester of *ENGR 10300: Introduction to Semiconductors* or a similar topical seminar.

III. Hands-on Semiconductor Experience: at least 6 credit hours or equivalent of:

- Research courses including relevant independent studies and Vertically Integrated Projects (VIP) courses, or
- Full-time internships relevant to technical areas of semiconductors and microelectronics. A summer or semester-long full-time internship/co-op/SURF or similar experience is considered equivalent to 6 credit hours.

- Approved hands-on lab courses – ECE 55700, ECE 33700, with more to be added.

Semiconductor and Microelectronic Devices
ECE 30500 - Semiconductor Devices
ECE 45300 – Fundamentals of Nanoelectronics
ECE 50616 - Physics and Manufacturing of Solar Cells
ECE 50631 - Fundamentals of Current Flow
ECE 50632 - Introduction to Quantum Transport
ECE 50633 - Boltzmann Law: Physics to Machine Learning
ECE 50653 – Fundamentals of Nanoelectronics
ECE 55700 - Integrated Circuit/MEMS Fabrication Laboratory
ECE 59500 - Essentials of Transistors
ECE 59500 – MEMS I: Microfabrication and Materials for MEMS (1 credit)
ECE 59500 - MEMS II: Fundamentals of MEMS Design (1 credit)
ECE 59500 - MEMS III: Applications in MEMS (1 credit)
ECE 59500 - Semiconductor Fundamentals
ECE 59500 - Theory and Practice of Solar Cells: A Cell to System Perspective
ECE 59500 – Advanced Lithography
ECE 59500 – Microfabrication Fundamentals
ECE 59500 – Semiconductor Manufacturing
PHYS 52600 - Physics of Quantum Computing and Quantum Information

Semiconductor Materials, Characterization, and Processing
CHE 42000 – Process Safety Management and Analysis
CHE 45600 – Process Dynamics and Control
CHE 56400 – Organic Electronic Materials and Devices
CHE 59700 – Manufacturing Advanced Composites
IE 37000 – Manufacturing Processes I
IE 38300 – Integrated Production Systems I
IE 47000 Manufacturing Processes II
IE 57000 Manufacturing Process Engineering
IE 57900 Design and Control of Production and Manufacturing Systems
IE 58300 Design and Evaluation of Material Handling Systems
ME 36300 - Principles and Practices of Manufacturing Processes
ME 55700 - Design for Manufacturability

MSE 26000 - Thermodynamics of Materials
MSE 33000 - Processing and Properties of Materials
MSE 33500 - Materials Characterization Laboratory
MSE 36700 - Materials Processing Laboratory
MSE 37000 - Electrical, Optical and Magnetic Properties of Materials
MSE 51000 - Microstructural Characterization Technique
MSE 51000 - Microstructural Characterization Techniques
MSE 53000 - Materials Processing in Manufacturing
MSE 54700 - Introduction to Surface Science
MSE 54800 - Deposition Processing of Thin Films and Coatings
MSE 55500 - Deformation Mechanisms in Crystalline Solids
MSE 59700I - Introduction to Computational Materials Science
MSE 69700C - Materials Issues in Microelectronics and Nanoelectronics
MSE 69700T /ECE69500T - Principles and Methods of Nanofabrication
NUCL 42001 - Radiation Interaction with Materials and Applications
NUCL 52000 - Radiation Effects and Reactor Materials
NUCL 55300 - Nano-Macro Scale Applications of Nuclear Technology

Integrated Circuit & System Design, Electronic Design Automation
ECE 33700 – ASIC Design Laboratory
ECE 36200 – Microprocessor Systems and Interfacing
ECE 45500 – Integrated Circuit Engineering
ECE 45600 – Digital Integrated Circuit Analysis and Design
ECE 51220 – Applied Algorithms
ECE 55900 – MOS VLSI Design
ECE 59500 – CMOS Analog IC Design
ECE 56800 – Embedded Systems
ECE 59500 – Digital Systems Design Automation
ECE 59500 – Computer Vision for Embedded Systems

Electronics Packaging, Heterogeneous Integration, and Thermal Management
CHE 32000 - Statistical Modeling and Quality Enhancement
ME 55900 - Micromechanics Of Materials
ME 597/ECE 595/MSE 597 Introduction to Electronics Packaging and Heterogeneous Integration

Semiconductor Manufacturing and Global Supply Chain Management
CHE 32000 - Statistical Modeling and Quality Enhancement
EEE 59700 Design for Sustainable Electronics
IE 38600 Work Analysis and Design I
IE 48400 Integrated Production Systems II
IE 48600 Work Analysis and Design II
IE 49000 Supply Chain Engineering
IE 53200 Reliability
IE 53300 Industrial Applications of Statistics
IE 55800 Safety Engineering
IE 56600 Production Management Control
IE 58200 Advanced Facilities Design
MGMT 26100 Introduction to Supply Chain Management
MGMT 40500 Six Sigma and Quality Analytics
MGMT 46200 Advanced Manufacturing Planning And Control Systems
MGMT 46300 Supply Chain Analytics
MGMT 47300 Data Mining
MGMT 47400 Predictive Analytics
MGMT 47900 Data Visualization

CATALOG INFORMATION

Proposed CIP Code: 15.1601

Rationale for Proposed CIP Code: Fits the description of 15.1601 NanoTechnology: A program that prepares individuals to apply mathematical, scientific, and engineering principles and technical skills to manipulate matter at the atomic and molecular level (in the range of 1-100 nanometers) and to design, fabricate, and integrate nanoscale structures, devices, and systems. Includes instruction in materials science, thermodynamics, nanomaterials, nanoelectronics, and nano/micro device fabrication and testing.

Proposed Program Code: SEMI-CERT

Proposed Certificate Code: SEMI

Proposed Credits: 16

Projected Headcount: 100

Length of Certificate: Award of at least 1 but less than 2 academic years

Characteristics: Undergraduate certificate open to various majors at Purdue, includes a required experiential learning component.

Assessment of Need: Please see rationale. Assessment of need based on various industry forecasts from SIA and SEMI.

Cost and Support: The program is part of the Purdue Semiconductor Degrees Program (SDP) and will be coordinated by staff in Office of Professional Practice.

Similar and Related Programs: There is no directly similar program at the undergraduate level. The School of ECE has a concentration in semiconductors for students in the BSEE and BSCmpE majors.

Quality and Other Aspects: The program will be coordinated by faculty across multiple schools in the College of Engineering through the Semiconductor Degrees Program Steering Committee.