From:	Smith, Randy
To:	Anderson, Betty Lise
Cc:	Leite, Fabio; Reed, Katie; Smith, Randy; Griffiths, Rob; Greenbaum, Rob; Duffy, Lisa; Hunt, Ryan; Quinzon-Bonello, Rosario; Tomasko, David; Miriti, Maria
Subject:	Revise Certificate Programs in Semiconductor Fabrication
Date:	Thursday, March 7, 2024 3:02:01 PM
Attachments:	image001.png

Betty Lise,

The proposal from the College of Engineering to revise the 3a and 3b Certificate Programs in Semiconductor Fabrication was approved by the Council on Academic Affairs at its meeting on March 6, 2024. Thank you for attending the meeting to respond to questions/comments.

No additional level of internal review/approval is necessary. This action will be included in the Council's next Annual Activities Report to the University Senate (July 2024).

The Office of the University Registrar will work you with any implementation issues.

Please keep a copy of this message for your file on the proposal and I will do the same for the file in the Office of Academic Affairs.

If you have any questions please contact the Chair of the Council, Professor Fábio Leite (.11), or me.

Randy

THE OHIO STATE UNIVERSITY

W. Randy Smith, Ph.D.
Vice Provost for Academic Programs
Office of Academic Affairs
University Square South, 15 E. 15th Avenue, Columbus, OH 43201
614-292-5881 Office
smith.70@osu.edu
Assisted by:
Katie Reed
Executive Assistant
(614) 292-5672
reed.901@osu.edu

TO: Randy Smith, Vice Provost for Academic Programs

FROM: Graduate School Curriculum Services

DATE: **2/15/2024**

RE: Proposal to **Revise the 3a & 3b Certificate Programs in Semiconductor Fabrication** in **College of Engineering**

The **Electrical and Computer Engineering** in the **College of Engineering** is proposing a **Revision to the Revise the 3a & 3b Certificate Programs in Semiconductor Fabrication.** The proposal was received by the Graduate School on **11/16/2023**. The combined GS/CAA subcommittee first reviewed the proposal on **1/31/2024** and requested revisions. Revisions were received on **2/06/2024**. The proposal is supported for elevation to CAA for review.

THE OHIO STATE UNIVERSITY

Department of Electrical and Computer Engineering

205 Dreese Labs
2015 Neil Avenue
Columbus, OH 43210

614-292-2572 Phone
614-292-7596 Fax
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Feb 6, 2024

Dean Miriti
Associate Dean of Academic Excellence, Graduate School
247E University Hall
230 N Oval Mall
Columbus OH 43210

Dear Dean Miriti,

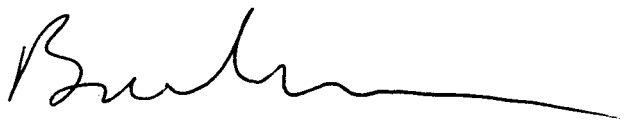
As requested by the combined Graduate School – Council on Academic Affairs committee, I am submitting the updated proposals for:

3A Grad Certificate for Semiconductor Fabrication Technology
3B Grad Certificate for Semiconductor Fabrication Technology

The changes are:

- Page numbers and revision date added to footer
- Dangling asterisks removed from table page 2 and table page 4
- Current enrollment in certificates added page 5, Section II.A.
- Inconsistencies in resources related to the labs removed page 6 Section III B

Sincerely yours,



Betty Lise Anderson, Ph.D.
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The Ohio State University
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THE OHIO STATE UNIVERSITY

College of Engineering

Undergraduate Education & Student Services

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Columbus, OH 43210-1278

614-292-2651 Phone
614-292-9379 Fax

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Memo

To: Maria Miriti, Associate Dean, Graduate School
From: Rosie Quinzon-Bonello, Assistant Dean for Curriculum and Assessment
Date: November 16, 2023
Re: Program Change Proposal to both Graduate Stand-Alone and Embedded Certificate Programs In Semiconductor Fabrication

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On November 9, 2023, The College of Engineering Committee for Academic Affairs approved the program changes proposal to both the Graduate Stand-Alone and Embedded Certificate Programs in Semiconductor Fabrication.

A summary of the changes is on page 2. Whilst these are two different types of certificates, (3a) and (3b), they are the same, so they have been presented in one document. The Track Changes tool has been selected so that reviewers can view and compare what has been revised.

Yours sincerely,

Rosie Quinzon-Bonello

I. Graduate Embedded Certificate in Semiconductor Fabrication Technology

Revision Feb 6 2024

Betty Lise Anderson, Department of Electrical and Computer Engineering

I. Program definition

A. Title of program

Graduate Embedded Certificate in Semiconductor Fabrication Technology

B. Certificate Category and Justification

The reshoring of microelectronics manufacturing, and the anticipated opening of semiconductor fabrication lines in central Ohio by Intel and nationwide by several semiconductor companies is expected to stimulate much interest in students acquiring skills in semiconductor devices, device physics, fabrication, and electronics.

C. Purpose of program

1. This certificate can be completed by graduates currently pursuing MS or Ph.D. degrees at Ohio State. It is expected that Intel and supporting industries will be seeking students with expertise in semiconductor devices.
2. Method of delivery will be primarily in-person, in accordance with current offering of the courses in the certificate. Additionally, there is a required laboratory component.

D. Methods of delivery

The courses are primarily offered in-person currently.

E. Timing

Desired start up is Autumn 2023.

F. Goals

The goal is to provide a mechanism for graduate students in engineering, math, and the physical sciences to demonstrate competency in semiconductor devices to potential employers, either in addition to their major degree outside electrical engineering, or beyond the requirements for their graduate degrees in Electrical and Computer Engineering degrees.

G. Outcomes

Upon completion of the academic certificate in Semiconductor Devices, learners will be better prepared to:

1. Know the processing technologies used for fabrication of silicon VLSI integrated circuits
2. Understand process integration for NMOS, CMOS, and MOS memory IC’s

H. Minimum requirements

A minimum GPA of 3.0 in the certificate courses is required for completion. Only grades of C- or better may be counted toward the certificate.

A.

Completion of the certificate requires a minimum of 13 credit hours. Of these, ECE 5530 is required. Additionally, at least one lab (5037 or 5537) is required (the labs are 4 credit hours each). The remaining six credits can be chosen from a pick list.

I. Methods of delivery

Number	Title	Online	In-person	In-person or online
5530	**Semiconductor Device Physics**		X	
5037	**Semiconductor Device Fabrication Lab**		X	
5537	**Semiconductor Device Characterization and Modeling Lab**		X	
5031	**Semiconductor Process Technology**		X	
5033	**Surfaces and Interfaces of Electronic Materials**		X	
5131	**Lasers**		X	
5132	**Photonics**		X	
5244	**Si and Wide Band Gap Power Devices**		X	
5833	**Organic Conducting Devices**		X	
6244	**Design and Process Integration for Wide Band Gap Power Devices**		X	
6531	**Fundamentals of Semiconductor Devices**		X	
6532	**Nanofabrication and Nanoscale Devices**		X	
7032	**Physical Electronics of Advanced Semiconductor Devices**		X	
7531	**Epitaxial Heterostructures**		X	

J. MOU with ODEE

Not required.

K. List of required and elective courses

1. Required:

E**CE 5530 Fundamentals of Semiconductors for Microelectronics and Photonics** (3 credits)

Current Prereqs: Prereq: 3030, or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.

Proposed changes: Prereqs: ECE 3030 or MATSCEN 3271 or grad standing in engineering, Biological Sciences, or Math and Physical Sciences. Also modify course topics to include more device physics and specifically silicon devices; course change request in progress

2. Pick at least one:

ECE 5037 Solid State Electronics and Photonics Laboratory (4 credits)

Proposed name change: Semiconductor Device Fabrication Lab

Current Prereqs: Prereq or concur: 3030, and acceptance in ECE, MSE or EngPhysics major; or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.

Proposed new prereqs: Prereq or concur: ECE 3030; or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.

ECE 5537 Semiconductor Device Characterization and Modeling Lab (4 credits)

Current Prereqs: Prereq: ECE 3030; or grad standing in Engineering or Physics.

Proposed new prereqs: Prereq: ECE 3030 or MATSCEN 3271; or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences

3. Additional courses (pick 2)

ECE 5031 Semiconductor Process Technology (3 credits)

Current Prereqs: Prereq: 3030, or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences. Offered every spring.

Proposed new prereqs: Prereq: ECE 3030 or MATSCEN 3271; or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences

ECE 5033 Surfaces and Interfaces of Electronic Materials (3 credits)

Current Prereqs: Prereq: 3030, and Physics 1250 or 1250H; or Grad standing in Engineering, Biological Science, or Math and Physical Sciences. Offered odd springs

Proposed new prereqs: Prereq: ECE 3030 or MATSCEN 3271; and PHYS 1250, 1250H, 1260, or 1270; or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences

ECE 5833 Organic and Printed Flexible Electronics (3 credits)

Current Prereqs: Prereq: 3030, or permission of instructor for non-ECE majors; or Grad standing in engineering, biological sciences, or math and physical sciences.

Proposed new prereqs: Prereqs: ECE 3030 or MATSCEN 3271 or permission of instructor for non-ECE majors; or grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.

ECE 6244 Design and Process Integration for Wide Band Gap Power Devices (3 credits)

Prereq: Grad standing in Engineering or Physics.

ECE 6531 Fundamentals of Semiconductor Devices (3 credits)

Prereq: 5530 (730), or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.

ECE 6532 Nanofabrication and Nanoscale Devices (3 credits)
Prereq: 6531, 5531, or 730, or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.

ECE 7032 Physical Electronics of Advanced Semiconductors Devices (3 credits)
Prereq: 5530 or 6531.

ECE 7531 Epitaxial Heterostructures (2 credits)
Prereq: Grad standing.

Note: A student completing the certificate must take at least one lab, but may choose another in addition as an elective.

L. Length of program compared to similar programs

Comparable. (See section VI)

M. Semesters of offering

Number	Title	Even Aut	Odd Spr	Odd Aut	Even Spr
5530	**Semiconductor Device Physics**	X		X	
5037	**Semiconductor Device Fabrication Lab**	X		X	
5537	**Semiconductor Device Characterization and Modeling Lab**		X		X
5031	**Semiconductor Process Technology**		X		X
5033	**Surfaces and Interfaces of Electronic Materials**		X		
5131	**Lasers**			X	
5132	**Photonics**	X			
5244	**Si and Wide Band Gap Power Devices**	X		X	
5833	**Organic and Printed Flexible Electronics**		X		
6244	**Design and Process Integration for Wide Band Gap Power Devices**		X		X
6531	**Fundamentals of Semiconductor Devices**		X		X
6532	**Nanofabrication and Nanoscale Devices**	Runs ≈ every three years			
7032	**Physical Electronics of Advanced Semiconductors Devices**		X		X
7531	**Epitaxial Heterostructures**	Runs ≈ every three years			

N. Transfer Credits

All courses in the Certificate must be taken at Ohio State.

O. Arranged/Individual Study Courses

Arranged individual study courses may not be applied to the certificate.

P. Overlap

All of the credits in the certificate may be counted toward the graduate degree.
A student taking a second certificate my count up to 7 credit hours from the first certificate toward the second. If taking a third certificate, up to 7 hours total from the first and second certificate may be counted toward the third.

II. Enrollment

A. Projected enrollment

There are no student enrolled in the certificate so far. With the proposed increased verlap with degree, we expect there will be more students who might be interested, potentially 10-20 per year

1. Will there be problems if too many students enroll in the certificate program?

This is not expected to happen, but if it does, class sizes will increase, or we could potentially open additional sections or offer some electives more often. These classes generally have modest enrollments (≈20-30) so this problem is not anticipated. The labs may experience bottlenecks and require additional sections to accommodate large enrollments, which in turn requires additional GTAs.

2. Will there be problems if too few students enroll in the certificate program?

No

B. Opportunities for graduates

Due to the CHIPS Act, semiconductor manufacturing in the US is expected to grow rapidly in the next decade. There is a clear need for graduates at all academic levels to support this industry in the coming year. Some of these are right here in Ohio, with the coming Intel fabs, but there are many additional jobs in places like California, Arizona, Vermont, New York, Oregon, and others.

C. Admission requirements

A minimum graduate GPA of 3.0 to apply. Initially admitted to the university as part of master's or Ph.D. degree program.

III. Sufficient resources

A. Adequacy and availability of facilities and staff

All courses listed above exist and are already offered. They run on the schedule listed under Section I.M.

B. Projected resource needs and plans to meet those needs

The certificate can run and serve students immediately. We have sufficient semiconductor faculty that we can add sections and new courses if there is enough demand. Significant investment has been made to upgrade the facilities and equipment for the 5037 lab.

If demand increases for the labs, we will need more GTAs to run the additional sections. Six GTAs have been promised by the College of Engineering from the Intel funds.

IV. Justifiable expenses

A. Additional Faculty

We currently have enough faculty with the appropriate expertise to offer the certificate.

B. Course additions or deletions

No new courses are needed at this time.

C. Necessary budget adjustments

We can run the certificate with existing resources.

D. Available and anticipated funding

Funding from an Intel grant for teaching assistants and equipment is available. Further resources, if needed, will be arranged in coordination with the college and university.

II. Adequate demand

A. Evidence of sufficient demand by students faculty, general public, and/or business

Intel is opening the first two of eight semiconductor fabrication lines (fabs) in central Ohio, scheduled to open 2025. They are recruiting interns now, who will spend 12-18 months in established Intel plants before returning to Ohio. The initial fabs will employ 3,000 people and more will be needed as the additional fabs come online. Additionally, there will be other support industries that will need graduates at all levels with semiconductor expertise.

B. Duration of demand (long/short term)

Intel is hiring people now so they can be trained now while the factory is being built, thus the demand is immediate. If the first two fabs are successful, Intel plans to build six more; thus the demand is expected to be ongoing for the foreseeable future.

C. Ability of other programs to meet demand

The Department of Electrical and Computer Engineering has a world-class faculty in semiconductor materials and devices, and already has many specialized

courses in these areas. We welcome the opportunity to add courses from other departments to these certificates as they become available, for example in Physics or Materials Science and Engineering.

V. Competitiveness with other institutions: limited overlap within the University

A. Overlap with other programs or departments

ECE has cordial relationships with Physics as well as Materials Science and Engineering, with multiple faculty members having joint appointments with those departments. We hope to add courses from those departments to these certificates as time goes by. We are trying to get the certificates approved quickly, so are starting with existing ECE courses.

B. Duplication of effort by other areas in the University, another university or another school

- Arizona State University has one embedded graduate certificate semiconductor processing. It is online, and appears to have no lab component.
- University of South Florida has an online embedded certificate in Semiconductor Technology and Manufacturing (STEM). It is online, and appears to have no lab component.
- Purdue is rapidly developing a semiconductor degree and certificate, and credentialing work force development

C. Similar programs at other universities in Ohio, or in the United States, and their levels of success

See above. Levels of success are not known.

Academic (Stand-alone) Certificate in Semiconductor Fabrication Technology

Revision Feb 6 2024

Betty Lise Anderson, Department of Electrical and Computer Engineering

I. Program definition

A. Title of program

Academic (stand-alone) certificate in Semiconductor Fabrication Technology

B. Certificate Category and Justification

The reshoring of microelectronics manufacturing, and the anticipated opening of semiconductor fabrication lines in central Ohio by Intel and nationwide by several semiconductor companies is expected to stimulate much interest in students acquiring skills in semiconductor devices, device physics, fabrication, and electronics.

C. Purpose of program

1. This certificate can be completed by professionals in engineering, math, and the physical sciences. It is expected that Intel and supporting industries will be seeking students with expertise in semiconductor devices.
2. Method of delivery will be primarily in-person, in accordance with current offering of the courses in the certificate. Additionally, there is a required laboratory component.

D. Methods of delivery

The courses are primarily offered in-person currently.

E. Timing

Desired start up is Autumn 2023.

F. Goals

The goal is to provide a mechanism for working professionals in engineering, math, and the physical sciences to demonstrate competency in semiconductor device fabrication technology to potential employers.

G. Outcomes

Upon completion of the academic certificate in Semiconductor Devices, learners will be better prepared to:

1) Know the processing technologies used for fabrication of silicon VLSI integrated circuits
2) Understand process integration for NMOS, CMOS, and MOS memory IC's

H. Minimum requirements

A bachelor of science in engineering or the physical sciences, or equivalent experience. Participants should be familiar with chemistry, calculus-based physics, and differential equations.
A minimum GPA of 3.0 in the certificate courses is required for completion. Only grades of C- or better may be counted toward the certificate.

Completion of the certificate requires a minimum of 13 credit hours. Of these, ECE 5530 is required. Additionally, at least one lab (5037 or 5537) is required (the labs are 4 credit hours each). The remaining six credits can be chosen from a pick list.

I. Methods of delivery

Number	Title	Online	In-person	In-person or online
ECE 5530	**Semiconductor Device Physics**		X	
ECE 5037	**Semiconductor Device Fabrication Lab**		X	
ECE 5537	**Semiconductor Device Characterization and Modeling Lab**		X	
ECE 5031	**Semiconductor Process Technology**		X	
ECE 5033	**Surfaces and Interfaces of Electronic Materials**		X	
ECE 5244	**Si and Wide Band Gap Power Devices**		X	
ECE 5833	**Organic Conducting Devices**		X	
ECE 6244	**Design and Process Integration for Wide Band Gap Power Devices**		X	
ECE 6531	**Fundamentals of Semiconductor Devices**		X	
ECE 6532	**Nanofabrication and Nanoscale Devices**		X	
ECE 7032	**Physical Electronics of Advanced Semiconductors Devices**		X	
ECE 7531	**Epitaxial Heterostructures**		X	

J. MOU with ODEE

Not required.

K. List of required and elective courses

1. Required:

E**CE 5530 Fundamentals of Semiconductors for Microelectronics and Photonics** (3 credits)
Prereq: 3030, or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.

Proposed changes: Prereqs: ECE 3030 or MATSCEN 3271 or grad standing in Engineering, Biological Sciences, or Math and Physical Sciences. Also modify course topics to include more device physics and specifically silicon devices; course change request in progress.

2. Pick at least one:

ECE 5037 Solid State Electronics and Photonics Laboratory (4 credits)

Proposed name change: Semiconductor Device Fabrication Lab

Current Prereqs: Prereq or concur: 3030, and acceptance in ECE, MSE or EngPhysics major; or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.

Proposed new prereqs: Prereq or concur: ECE 3030; or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.

ECE 5537 Semiconductor Device Characterization and Modeling Lab (4 credits)

Current Prereqs: Prereq: ECE 3030; or grad standing in Engineering or Physics.

Proposed changes: Prereq: ECE 3030 or MATSCEN 3271; or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.

3. Additional courses (pick 2)

ECE 5031 Semiconductor Process Technology (3 credits)

Current Prereqs: Prereq: 3030, or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences. Offered every spring.

Proposed changes: Prereq: ECE 3030 or MATSCEN 3271; or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.

ECE 5033 Surfaces and Interfaces of Electronic Materials (3 credits)

Current Prereqs: Prereq: 3030, and Physics 1250 or 1250H; or Grad standing in Engineering, Biological Science, or Math and Physical Sciences. Offered odd springs

Proposed changes: Prereq: ECE 3030 or MATSCEN 3271, and PHYS 1250, 1250H, 1260, or 1270; or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.

ECE 5833 Organic and Printed Flexible Electronics (3 credits)

Current Prereqs: Prereq: 3030, or permission of instructor for non-ECE majors; or Grad standing in engineering, biological sciences, or math and physical sciences.

Proposed changes: Prereq: ECE 3030 or MATSCEN 3271; or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.

ECE 6244 Design and Process Integration for Wide Band Gap Power Devices (3 credits)

Prereq: Grad standing in Engineering or Physics.

ECE 6531 Fundamentals of Semiconductor Devices (3 credits)

Prereq: 5530 (730), or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.

ECE 6532 Nanofabrication and Nanoscale Devices (3 credits)
Prereq: 6531, 5531, or 730, or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.

ECE 7032 Physical Electronics of Advanced Semiconductors Devices (3 credits)
Prereq: 5530 or 6531.

ECE 7531 Epitaxial Heterostructures (2 credits)
Prereq: Grad standing.

Note: A student completing the certificate must take at least one lab, but may choose another in addition as an elective.

L. Length of program compared to similar programs

Comparable. (See section VI)

M. Semesters of offering

Number	Title	Even Aut	Odd Spr	Odd Aut	Even Spr
5530	**Semiconductor Device Physics**	X		X	
5037	**Semiconductor Device Fabrication Lab**	X		X	
5537	**Semiconductor Device Characterization and Modeling Lab**		X		X
5031	**Semiconductor Process Technology**		X		X
5033	**Surfaces and Interfaces of Electronic Materials**		X		
5244	**Si and Wide Band Gap Power Devices**	X		X	
5833	**Organic and Printed Flexible Electronics**		X		
6244	**Design and Process Integration for Wide Band Gap Power Devices**		X		X
6531	**Fundamentals of Semiconductor Devices**		X		X
6532	**Nanofabrication and Nanoscale Devices**	Runs ≈ every three years			
7032	**Physical Electronics of Advanced Semiconductors Devices**		X		X
7531	**Epitaxial Heterostructures**	Runs ≈ every three years			

N. Transfer Credits

All courses in the Certificate must be taken at Ohio State.

O. Arranged/Individual Study Courses

Arranged individual study courses may not be applied to the certificate.

P. Overlap

- A student taking a second certificate my count up to 7 credit hours from the first certificate toward the second. If taking a third certificate, up to 7 hours total from the first and second certificate may be counted toward the third.

II. Enrollment

A. Projected enrollment

There are no students enrolled in this certificate so far. When Intels opens, there may be more students who might be interested, potentially 10-20 per year

1. Will there be problems if too many students enroll in the certificate program?

This is not expected to happen, but if it does, class sizes will increase, or we could potentially open additional sections or offer some electives more often. These classes generally have modest enrollments (≈20-30) so this probem is not anticipated. The labs may experience bottlenecks and require additional sections to accommodate large enrollments, which in turn requires additional GTAs. We have been promised additional GTA support by the College of Engineering.

2. Will there be problems if too few students enroll in the certificate program?

No.

B. Opportunities for graduates

Due to the CHIPS Act, semiconductor manufacturing in the US is expected to grow rapidly in the next decade. There is a clear need for graduates at all academic levels to support this industry in the coming year. Some of these are right here in Ohio, with the coming Intel fabs, but there are many additional jobs in places like California, Arizona, Vermont, New York, Oregon, and others.

C. Admission requirements

A bachelor of science in engineering or the physical sciences, with a GPA of 3.0, or equivalent experience. Participants should be familiar with chemistry, calculus-based physics, and differential equations.

III. Sufficient resources

A. Adequacy and availability of facilities and staff

All courses listed above exist and are already offered. They run on the schedule listed under Section I.M. labs: We have recently made a large investment in ECE 5037 to update the facilities and equioment.

Projected resource needs and plans to meet those needs

The certificate can run and serve students immediately. We have sufficient semiconductor faculty that we can add sections and new courses if there is enough demand.

If demand increases for the labs, we will need more GTAs to run the additional sections. Six GTAs have been promised by the College of Engineering from the Intel funds.

IV. Justifiable expenses

A. Additional Faculty

We currently have enough faculty with the appropriate expertise to offer the certificate.

B. Course additions or deletions

No new courses are needed at this time.

Necessary budget adjustments

We can run the certificate with existing resources.

Available and anticipated funding

Funding from an Intel grant for teaching assistants and equipment is available. Further resources, if needed, will be arranged in coordination with the college and university.

V. Adequate demand

A. Evidence of sufficient demand by students faculty, general public, and/or business

Intel is opening the first two of eight semiconductor fabrication lines (fabs) in central Ohio, scheduled to open 2025. They are recruiting interns now, who will spend 12-18 months in established Intel plants before returning to Ohio. The initial fabs will employ 3,000 people and more will be needed as the additional fabs come online. Additionally, there will be other support industries that will need graduates at all levels with semiconductor expertise.

B. Duration of demand (long/short term)

Intel is hiring people now so they can be trained now while the factory is being built, thus the demand is immediate. If the first two fabs are successful, Intel plans to build six more; thus the demand is expected to be ongoing for the foreseeable future.

C. Ability of other programs to meet demand

The Department of Electrical and Computer Engineering has a world-class faculty in semiconductor materials and devices, and already has many specialized courses in these areas. We welcome the opportunity to add courses from other departments to these certificates as they become available, for example in Physics or Materials Science and Engineering.

VI. Competitiveness with other institutions: limited overlap within the University

A. Overlap with other programs or departments

ECE has cordial relationships with Physics as well as Materials Science and Engineering, with multiple faculty members having joint appointments with those departments. We hope to add courses from those departments to these certificates as time goes by. We are trying to get the certificates approved quickly, so are starting with existing ECE courses.

B. Duplication of effort by other areas in the University, another university or another school

- Arizona State University has one professional graduate certificate semiconductor processing for people with BS or MS in engineering or related fields. It is online, and appears to have no lab component. 15 Credits hours.
- Portland State University has a professional graduate certificate in Semiconductor Materials and Manufacturing Overview, offered on campus (in Mechanical Engineering). Two of the available 8 courses have labs.
- Purdue is rapidly developing a semiconductor degree and certificate, and credentialing work force development

C. Similar programs at other universities in Ohio, or in the United States, and their levels of success

See above. Levels of success are not known.