From:	Smith, Randy
To:	Anderson, Betty Lise
Cc:	Leite, Fabio; Reed, Katie; Smith, Randy; Duffy, Lisa; Hunt, Ryan; Shanker, Balasubramaniam; Quinzon-Bonello, Rosario; Tomasko, David
Subject:	Proposal to revise the UG Minor and Embedded Certificate in Semiconductor Devices
Date:	Sunday, February 25, 2024 9:06:33 AM
Attachments:	image001.png

Betty Lise:

The proposal from the Department of Electrical and Computer Engineering to revise the undergraduate minor and embedded certificate in Semiconductor Devices was approved by the Council on Academic Affairs at its meeting on February 21, 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
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Memo

To: Randy Smith, Vice Provost for Academic Programs
From: Rosie Quinzon-Bonello, Assistant Dean for Curriculum and Assessment
Date: January 11, 2024
Re: Program Change Proposal to both the UG Minor and Embedded Certificate in **Semiconductor Devices** submitted by the Department of Electrical and Computer Engineering

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On January 10, 2024, The College of Engineering Committee for Academic Affairs approved the program changes to both the UG Minor and Embedded Certificate in **Semiconductor Devices**.

A summary of the changes is on page 2. Whilst one program change proposal is for the minor and the second for the embedded certificate, the content is 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

October 12, 2023

To: **Boyd Panton, CCAA Chair**

RE: **Program Changes to ECE Curriculum in the Undergraduate Minor and Embedded Certificate in Semiconductor Devices**

In this document you will find changes to our Electrical and Computer Engineering undergraduate minor and embedded certificate in Semiconductor Devices.

Embedded UG Certificate in Semiconductor Devices:

- Increase overlap hours to 100%
- Add some courses from other departments (we have concurrences from all)
- Updated special rules for ECE students
- Added exclusion between minor and certificate
- Propose changes to ECE 3030 prerequisites to allow easier access to students outside engineering
- Propose changes to other ECE course prereqs to allow in students from MATSCENG 3271 path
- Removed notes about updating the labs; the updating has been done.

Minor in Semiconductor Devices

- Add some courses from other departments (we have concurrences from all)
- Clarified rules for ECE students
- Added exclusion between minor and certificate
- Propose changes to ECE 3030 prerequisites to allow easier access to students outside engineering
- Propose changes to other ECE course prereqs to allow in students from MATSCEN 3271 path
- Changes to prereqs of other courses to allow students in from MATSCEN 3271

You will find these changes on the following page numbers:

Certificates/Minors	**Page Numbers**
Undergraduate Minor in Semiconductor Devices	3-10
Undergraduate Embedded Certificate in Semiconductor Devices	11-22

If you have any further questions, please feel free to contact me at Anderson.67@osu.edu

Best Regards,

Dr. Bette Lise Anderson

Proposal for an Undergraduate Minor in Semiconductor Devices: Revision September 15, 2023

Betty Lise Anderson, Department of Electrical and Computer Engineering

Motivation

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.

Target audience

Undergraduates in engineering, math, physical sciences. These students will likely have the necessary math and physics course to go directly into the courses in this minor.

Timing

Desired start up is Autumn 2023.

Coursework

Completion of the minor requires a minimum of 13 credit hours. Of these, ECE 3030 Semiconductor Electronic Devices (3 credits), or MATSCI 3271 Electronic Properties of Materials (3 credits), are required gateway courses; equivalent courses not identified here may be approved by petition. (Special rules apply to ECE students; see below). ECE 5530 is also required. Additionally, at least one lab (currently among ECE 5037, 5537 or MATSCEN 5532) is required. The ECE labs are currently listed as 4 credits, whereas the MATSCEN option is currently only 1 credit (but likely to be increased following ongoing curriculum review). The remaining credits can be chosen from a pick list.

Required:

ECE 3030 Semiconductor Device Physics (3 credits)

Current Prereqs: 2020, 2021, or 2100; and Physics 1251, 1261, or both 1240 and 1241; and Chem 1210, 1220, or 1250; and enrollment in ECE, MSE, or EngPhysics major. Prereq or concur: Math 2415 or 2174.

<u>Proposed new prereqs:</u> Physics 1251, 1261, or both 1240 and 1241; and Chem 1210, 1250, 1620, or 1920H. Prereq or concur: Math 2415, 2255, 2177, or 2174. Offered every semester.

- or -

MATSCEN 3271 Electronic Properties (3 credits)

Current Prereqs: MSE 2010; Physics 1251 or 1261; Calculus I; or permission of instructor
Proposed new prereqs: MSE 2010 or MSE 2241 or equivalent; Physics 1251 or 1261; Calculus I; or permission of instructor.

Also required:

ECE 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: Prereq: 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

Pick at least one lab:

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)

Prereq: ECE 3030 or MATSCEN 3271; 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.

MATSCEN 5532 Electronic and Optical Materials Lab (1 credits)

Current Prereqs: MSE2010, MSE2241, MSE3271, or permission of instructor.
Proposed new prereqs: ECE 3030 or MSE 3271; or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences or permission of instructor.

Additional courses: (choose as necessary to reach 13 credits)

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 5131 Lasers (3 credits)

Current Prereqs: Prereq: 3010 and 3030 or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.

Proposed changes: Prereq: ECE 3010; and ECE 3030 or MATSCEN 3271; or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.

ECE 5132 Photonics (3 credits)

Current Prereqs: Prereq: 3010 and 3030 or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.

Proposed changes: Prereq: ECE 3010; and ECE 3030 or MATSCEN 3271; or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.

ECE 5244 Si and Wide Band Gap Power Devices (3 credits)

Current Prereqs: Prereq: 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.

ECE 5832 Photovoltaics and Energy Conversion (3 credits

Current Prereqs: Prereq: 3030, or Grad standing in Engr or Physics.
Proposed changes: Prereq: ECE 3030 or MATSCEN 3271; 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.

MATSCEN 5571 Electroceramics II (Dielectric, Magnetic, & Optical Ceramics) (1.5 credits)

Prereq: MSE 3271 (or concur) or permission of instructor. 7-week course.

MATSCEN 5572 Materials for Sustainable Energy Technologies (3 credits)

Current Prereqs: Prereq: MSE 2010 and either MSE 3271 or ECE 2300; permission of instructor.

Proposed new prereqs: Prereq or concur: ECE 3030 or MSE 3271; Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences or permission of instructor.

MATSCEN 5952 Failure Analysis of Materials (3 credits)

Prereq: Sr or Grad standing in MatScEn or WeldEng, or permission of instructor.

STAT 3470 Introduction to Probability and Statistics for Engineers (3 credits)

Prereq: MATH 1152, 1161.xx, 1172, 1181H, or equiv, or permission of instructor. Not open to students with credit for STAT 3440, 3450, 3450.01, 3450.02, 3460, 3470, or 3470.02. GE data anly course.

PHYS 3700 Experimental Physics Instrumentation and Data Analysis Lab (3 credits)

Prereq: Physics 1251 or 1251H or 1261; and CSE 1222 or CSE 1223 or Engineering 1281H or Astronomy 1221.

MECHENG 3500 Engineering Thermal Sciences (3 credits)

Prereq: Math 2174 or 2177 or 2255 or 2415, and Physics 1250. Not open to students enrolled in MechEng major.

MECHENG 4510 Heat Transfer (3 credits)

Prereq: MECHENG 3503 or 3504, and MechEng-BS student (no pre-majors); or permission of instructor.

ISE 4120 Quality and Reliability Engineering (3 credits)

Prereq: STAT 3470, and enrollment in ISE major or EngPhys major.

ISE 5110 Design of Engineering Experiments (3 credits)

Prereq: ISE 4210; or Grad standing with STAT 3470 or equiv.

CBE 3421 Transport Phenomena II - Heat Transfer (3 credits)

Prereq: CBE 2420, or permission of instructor.

CBE 5779 Design and Analysis of Experiments (3 credits)

Prereq: Jr or Sr standing in CBE.

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

Semesters of offering

Number	Title	Even Aut	Odd Spr	Odd Su	Odd Aut	Even Spr	Even Su
ECE 3030	Semiconductor Device Physics	X	X		X	X	
ECE 5530	Fundamentals of Semiconductors for Microelectronics and Photonics	X			X		
ECE 5037	Solid State Electronics and Photonics Laboratory	X			X		
ECE 5537	Semiconductor Electronics and Photonics Lab*		X			X	
ECE 5031	Semiconductor Process Technology		X			X	
ECE 5033	Surfaces and Interfaces of Electronic Materials		X				
ECE 5131	Lasers				X		
ECE 5132	Photonics	X					
ECE 5244	Si and Wide Band Gap Power Devices	X			X		
ECE 5832	Photovoltaics and Energy Conversion				X		
ECE 5833	Organic Conducting Devices		X				
CBE 3421	Transport Phenomena II - Heat Transfer						

CBE 5779	Design and Analysis of Experiments						
MATSCEN 3271	Electronic Properties		X			X	
MATSCEN 5532	Electronic and Optical Materials Lab	X			X		
MATSCEN 5571	Electroceramics II (Dielectric, Magnetic, & Optical Ceramics)		X			X	
MATSCEN 5572	Materials for Sustainable Energy Technologies	X			X		
MATSCEN 5952	Failure Analysis of Materials		X			X	
STAT 3470	Introduction to Probability and Statistics for Engineers	X	X	X	X	X	X
PHYS 3700	Experimental Physics Instrumentation and Data Analysis Lab	X	X	X	X	X	X
MECHENG 3500	Engineering Thermal Sciences	X	X		X	X	
MECHENG 4510	Heat Transfer	X			X		
ISE 4120	Quality and Reliability Engineering	X	X		X	X	
ISE 5110	Design of Engineering Experiments	X	X		X	X	

Resources required

All courses listed above exist and are already offered. 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.

Admission requirements

Minimum GPA of 1.7 (C-) to apply. Initially admitted to the university as part of and Associates or Bachelors Degree program.

Completion requirements

Minimum GPA of 2.0 in the minor courses. Only grades of C- or better may be counted toward the minor.

Pass/Nonpass Courses

No courses graded Pass/Non-Pass may be applied to the minor.

Independent Study, Satisfactory/Unsatisfactory courses

Up to three credit hours of xx93 or courses graded Satisfactory/Unsatisfactory may be counted toward the minor.

Transfer Credits

At least half of the credits counting toward the minor must be earned in regular OSU coursework.

Overlap with the major and additional minors

The minor must be in a different subject from the major (as identified by the registrar's official listing of approved majors)

Each minor completed must contain a minimum of 12 credit hours distinct from the major and/or additional minors (i.e., if a minor requires more than 12 credit hours, a student is permitted to overlap those credit hours beyond 12 with the major or with another minor)."

Overlap with the GE

A student is permitted to overlap up to 6 credit hours between the GE and a minor.

Electrical and Computer Engineering Students

ECE has two programs of study, electrical engineering program of study (EES) and computer engineering program of study (CES).

- EES students are required to complete three "domains" for their major, choosing two electives in one domain and one elective in each of two other domains. There are six domains. One of the domains is "solid state electronics and photonics." ECE students desiring to obtain this minor may take four courses from the list above, excepting ECE 3030, which is required of EES students, and ECE 5530, and at least one lab from ECE from among ECE 5037, ECE 5537 and MATSCEN 5532. They may choose electives from the list to make up the remaining credits to get to 13 hours. Of those electives, up to 6 credits from list above can count toward the solid state domain *and* the minor simultaneously. EES students are also required to take STAT 3470, which may also be counted toward both the degree and the minor.

CES students are not required to take ECE 3030 for their major. They must take 16 hours of technical electives, of which 9 must be from a list specific to computer engineers They may therefore take up to 7 hours of ECE technical electives outside that list, which may be solid state courses. Thus a CES student could count ECE 3030 and 5530 toward those six hours to degree *and* toward the minor simultaneously; they would need to take either the 5037 lab or the 5537 lab, and one additional solid state elective from the table above to complete the certificate. CES students are also required to take STAT 3470, which may also be counted toward both the degree and the minor.

Exclusions

A student receiving the Minor in Semiconductor Devices may not also receive the Certificate in Semiconductor Devices.

Outcomes

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

1) Understand advanced semiconductor physics
2) Understand electronic and optical properties of semiconductors
3) Understand the principles of new electronics devices as new technologies develop.

Proposal for an Undergraduate Embedded Certificate in Semiconductor Devices: September 18, 2023

Betty Lise Anderson, Department of Electrical and Computer Engineering

Updated: July 28, 2023

Tyler Grassman, Department of Materials Science and Engineering

Siddharth Rajan, Department of Electrical and Computer Engineering

I. Program definition

A. Title of program

Undergraduate Embedded Certificate in Semiconductor Devices

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 undergraduates currently pursuing BS 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 undergraduate 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 BS in Electrical and Computer Engineering degrees.

G. Outcomes

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

1. Understand semiconductor physics
2. Understand electronic and optical properties of semiconductors
3. Understand the principles of new electronics devices as new technologies develop.

H. Minimum requirements

A minimum GPA of 2.0 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 3030 Semiconductor Electronic Devices (3 credits) or MATSCI 3271 Electronic Properties of Materials (3 credits) , are required gateway courses; equivalent courses not identified here may be approved by petition. ECE 5530 is also required. Additionally, at least one lab (currently among ECE 5037, ECE5537, or MATSCEN 5532) is required. The ECE labs are currently listed as 4 credits, whereas the MATSCEN option is currently only 1 credit (but likely to be increased following ongoing curriculum review). The remaining credits can be chosen from a pick list.

Special Rules apply to ECE undergraduate students; see Section 1.Q.

I. Methods of delivery

Number	Title	Online	In-Person	In-person or online
3030	**Semiconductor Device Physics**		X	
5530	**Fundamentals of Semiconductors for Microelectronics and Photonics**		X	
5037	**Solid State Electronics and Photonics Laboratory**		X	
5537	**Semiconductor Electronics and Photonics 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	
5832	**Advanced Photovoltaics**		X	
5833	**Organic and Printed Flexible Electronics**		X	
CBE 3421	Transport Phenomena II - Heat Transfer		X	
CBE 5779	Design and Analysis of Experiments		X	
MATSCEN 3271	Electronic Properties		X	

MATSCEN 5532	Electronic and Optical Materials Lab		X	
MATSCEN 5571	Electroceramics II (Dielectric, Magnetic, & Optical Ceramics)			X
MATSCEN 5572	Materials for Sustainable Energy Technologies		X	
MATSCEN 5952	Failure Analysis of Materials		X	
STAT 3470	Introduction to Probability and Statistics for Engineers			X

J. MOU with ODEE

Not required.

K. List of required and elective courses

1. Required:

ECE 3030 Semiconductor Device Physics (3 credits)

Current Prereqs: 2020, 2021, or 2100; and Physics 1251, 1261, or both 1240 and 1241; and Chem 1210, 1220, or 1250; and enrollment in ECE, MSE, or EngPhysics major. Prereq or concur: Math 2415 or 2174.

Proposed new prereqs: Physics 1251, 1261, or both 1240 and 1241; and Chem 1210, 1250, 1620, or 1920H. Prereq or concur: Math 2415, 2255, 2177, or 2174. Offered every semester.

- or -

MATSCEN 3271 Electronic Properties (3 credits)

Current Prereqs: MSE 2010; Physics 1251 or 1261; Calculus I; or permission of instructor
Proposed new prereqs: MSE 2010 or MSE 2241 or equivalent; Physics 1251 or 1261; Calculus I; or permission of instructor.

Also required:

ECE 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: ECE 3030 or MASTSCEN 3271 or Grad standing in biological science, math, or 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.:

MATSCEN 5532 Electronic and Optical Materials Lab (1 credits)

Current Prereqs: MSE2010, MSE2241, MSE3271, or permission of instructor.

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

3. Additional courses (choose as necessary to reach 13 credits)

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

ECE 5131 Lasers (3 credits)

Current Prereqs: Prereq: 3010 and 3030 or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.

Proposed changes: Prereq: ECE 3010; and ECE 3030 or MATSCEN 3271; or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.

ECE 5132 Photonics (3 credits)

Current Prereqs: Prereq: 3010 and 3030 or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.

Proposed changes: Prereq: ECE 3010; and ECE 3030 or MATSCEN 3271; or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.

ECE 5244 Si and Wide Band Gap Power Devices (3 credits)

Current Prereqs: 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.

ECE 5832 Photovoltaics and Energy Conversion (3 credits

Current Prereqs: Prereq: 3030, or Grad standing in Engr or Physics.

Proposed changes: Prereq: ECE 3030 or MATSCEN 3271; 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.

MATSCEN 5571 Electroceramics II (Dielectric, Magnetic, & Optical Ceramics) (1.5 credits)

Prereq: MSE 3271 (or concur) or permission of instructor. 7-week course.

MATSCEN 5572 Materials for Sustainable Energy Technologies (3 credits)

Prereq: MSE 2010 and either MSE 3271 or ECE 2300; permission of instructor.

Proposed new preregs: Prereq or concur: ECE 3030 or MSE 3271; Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences or permission of instructor.

MATSCEN 5952 Failure Analysis of Materials (3 credits)

Prereq: Sr or Grad standing in MatScEn or WeldEng, or permission of instructor.

STAT 3470 Introduction to Probability and Statistics for Engineers (3 credits)

Prereq: MATH 1152, 1161.xx, 1172, 1181H, or equiv, or permission of instructor. Not open to students with credit for STAT 3440, 3450, 3450.01, 3450.02, 3460, 3470, or 3470.02. GE data anly course.

PHYS 3700 Experimental Physics Instrumentation and Data Analysis Lab (3 credits)

Prereq: Physics 1251 or 1251H or 1261; and CSE 1222 or CSE 1223 or Engineering 1281H or Astronomy 1221.

MECHENG 3500 Engineering Thermal Sciences (3 credits)

Prereq: Math 2174 or 2177 or 2255 or 2415, and Physics 1250. Not open to students enrolled in MechEng major.

MECHENG 4510 Heat Transfer (3 credits)

Prereq: MECHENG 3503 or 3504, and MechEng-BS student (no pre-majors); or permission of instructor.

ISE 4120 Quality and Reliability Engineering (3 credits)

Prereq: STAT 3470, and enrollment in ISE major or EngPhys major.

ISE 5110 Design of Engineering Experiments (3 credits)

Prereq: ISE 4210; or Grad standing with STAT 3470 or equiv.

CBE 3421 Transport Phenomena II - Heat Transfer (3 credits)

Prereq: CBE 2420, or permission of instructor.

CBE 5779 Design and Analysis of Experiments (3 credits)

Prereq: Jr or Sr standing in CBE.

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.

M. Semesters of offering

Number	Title	Even Aut	Odd Spr	Odd Su	Odd Aut	Even Spr	Even Su
ECE 3030	Semiconductor Device Physics	X	X		X	X	
ECE 5530	Fundamentals of Semiconductors for Microelectronics and Photonics	X			X		
ECE 5037	Solid State Electronics and Photonics Laboratory	X			X		
ECE 5537	Semiconductor Electronics and Photonics Lab*		X			X	
ECE 5031	Semiconductor Process Technology		X			X	
ECE 5033	Surfaces and Interfaces of Electronic Materials		X				
ECE 5131	Lasers				X		
ECE 5132	Photonics	X					
ECE 5244	Si and Wide Band Gap Power Devices	X			X		
ECE 5832	Photovoltaics and Energy Conversion				X		
ECE 5833	Organic Conducting Devices		X				
CBE 3421	Transport Phenomena II - Heat Transfer						
CBE 5779	Design and Analysis of Experiments						
MATSCEN 3271	Electronic Properties		X			X	
MATSCEN 5532	Electronic and Optical Materials Lab	X			X		
MATSCEN 5571	Electroceramics II (Dielectric, Magnetic, & Optical Ceramics)		X			X	
MATSCEN 5572	Materials for Sustainable Energy Technologies	X			X		
MATSCEN 5952	Failure Analysis of Materials		X			X	
STAT 3470	Introduction to Probability and Statistics for Engineers	X	X	X	X	X	X

PHYS 3700	Experimental Physics Instrumentation and Data Analysis Lab	X	X	X	X	X	X
MECHENG 3500	Engineering Thermal Sciences	X	X		X	X	
MECHENG 4510	Heat Transfer	X			X		
ISE 4120	Quality and Reliability Engineering	X	X		X	X	
ISE 5110	Design of Engineering Experiments	X	X		X	X	

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 undergraduate degree.

Q. Electrical and Computer Engineering Students

ECE has one major (Electrical and Computer Engineering), but two programs of study, electrical engineering program of study (EES) and computer engineering program of study (CES).

- EES students are required to complete three "domains", choosing two electives in one domain and one elective in each of two other domains. There are six domains. One of the domains is "solid state electronics and photonics." ECE students desiring to obtain this certificate may take four courses from the list above, including ECE 3030 (required of EES students, and ECE 5530, and at least one lab from ECE from among ECE 5037, ECE 5537 and MATSCEN 5532. ECE students are also required to take STAT 3470, which can also be counted toward both the degree and the certificate.

- CES students are not required to take ECE 3030 for their major. They must take 16 hours of technical electives, of which 9 must be from a list specific to computer engineers They may therefore take up to 7 hours of ECE technical electives outside that list, which may be solid state courses. Thus a CES student could take ECE 3030 and 5530 and count those six hours to the major degree *and* toward the certificate; they would need to take one of the labs (5537 or 5037) and one additional solid state elective from the table above to complete the certificate.

R. R. Exclusions

A student receiving the Certificate in Semiconductor Devices may not also receive the Minor in Semiconductor Devices.

II. Enrollment

A. Projected enrollment

We have no experience with these certificates, so we can only guess at the number of 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. We have been promised additional GTA help from 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 minimum GPA of 1.7 (C-) to apply. Initially admitted to the university as part of an Associates or Bachelors Degree program. An embedded certificate program is "declared" in a similar path to majors.

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.

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.

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

A google search did not turn up any undergraduate certificates in semiconductors in the US.

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

No similar programs exist as far as we know.