From:	Smith, Randy
To:	Grassman, Tyler
Cc:	Leite, Fabio; Reed, Katie; Smith, Randy; Duffy, Lisa; Orr, James; Quinzon-Bonello, Rosario; Tomasko, David
Subject:	Proposal to establish an undergraduate certificate in Semiconductor Processing and Manufacturing Technologies
Date:	Thursday, November 2, 2023 10:25:58 PM
Attachments:	image001.png

Tyler:

The proposal from the Department of Materials Science and Engineering to establish an undergraduate certificate in Semiconductor Processing and Manufacturing Technologies was approved by the Council on Academic Affairs at its meeting on November 1, 2023. Thank you for attending the meeting to respond to questions/comments.

No additional level of internal 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
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Memo

To: Randy Smith, Vice Provost for Academic Programs, Office of Academic Affairs
From: Rosie Quinzon-Bonello, Assistant Dean for Curriculum and Assessment
Date: October 13, 2023

Re: UG Embedded Certificate in Semiconductor Processing and Manufacturing Technologies

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On September 18, 2023, the College of Engineering Committee on Academic Affairs unanimously approved the UG Embedded Certificate in Semiconductor Processing and Manufacturing Technologies, which was submitted by the Department of Materials Science and Engineering and the Department of Electrical and Computer Engineering.

Attached is the proposal.

Yours sincerely,

Rosario Quinzon-Bonello

Rosie Quinzon-Bonello

THE OHIO STATE UNIVERSITY

Prof. Tyler J Grassman
Associate Professor
Dept. of Materials Science & Engineering
Dept. of Electrical & Computer Engineering
The Ohio State University
4012 Fontana Labs, 140 W 19th Ave
Columbus, OH 43210

Phone: 614-688-1704
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September 8, 2023

Committee on Academic Affairs
College of Engineering
The Ohio State University
Columbus, OH 43210

Dear CCAA members,

We are pleased to present for your consideration, and hopefully ultimate approval, the follow application for a new Undergraduate Embedded academic certificate in *Semiconductor Processing and Manufacturing Technologies.* The reshoring and domestic growth of microelectronics manufacturing throughout the United States has created the need for rapid development of a large domestic semiconductor workforce. Similarly, the arrival of Intel (and its many supporting industries) here in Ohio is expected to stimulate much student interest in acquiring knowledge and skills in semiconductors, semiconductor devices, and the science and technologies behind their manufacturing, either out of curiosity or to build their careers in the field. As such, this highly interdisciplinary certificate has been created to address these needs, wherein the intent of the certificate is to help round out the student's main major curriculum with curated courses from a range of science and engineering disciplines that will better prepare them for entry into the aforementioned semiconductor and given them a leg up when they begin their job search.

This certificate was developed with participation from multiple engineering and natural sciences departments — MSE, ECE, CBE, MAE, ISE, CHEM, and PHYS — as well as input from Intel's higher-ed liaisons, recruiters, and source matter experts (as part of the OSU-led, Intel-funded semiconductor curriculum and training development project). The certificate will be jointly administered and advised by the MSE and ECE departments; the authors of this application, coming from both host departments, will serve as subject matter experts to address questions as needed. Concurrence has been granted by all departments from which courses have been included; copies of emails to this effect are included. Note that in some cases those departments presented additional comments and/or requests (generally for clarification, but in some cases for consideration of pre-requisite changes to better accommodate their students, such as for ECE 3030). These requests are generally reasonable and beneficial and thus have been accounted for in this document; official changes are being handled at the appropriate departmental levels.

Should any questions or concerns arise, we invite you to get in touch and we will be happy to quickly answer and/or address them. Thank you for your time and consideration.

Sincerely,

Tyler Grassman, Dept. of Materials Science and Engineering, grassman.5@osu.edu
Siddharth Rajan, Dept. of Electrical and Computer Engineering, rajan.21@osu.edu

Proposal for an Undergraduate Embedded Certificate in Semiconductor Processing and Manufacturing Technologies

July 25, 2023

Tyler Grassman, Dept. of Materials Science & Engineering
Siddharth Rajan, Dept. of Electrical & Computer Engineering

I. Program definition

A. Title of program

Undergraduate Embedded Certificate in Semiconductor Processing and Fabrication Technologies

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 other semiconductor companies, as well as the rapid growth in associated supply chain industries, is expected to stimulate much interest in students acquiring skills in semiconductors, semiconductor devices, and the science and technologies behind their manufacturing. As such, the proposed certificate is in the form of an **Undergraduate Embedded** type, wherein the intent of the certificate is to round out the student's main major curriculum with curated interdisciplinary courses that will better prepare them for entry into the aforementioned semiconductor manufacturing workforce.

This certificate will be jointly administered and advised by the MSE and ECE departments; the authors of this application, coming from both host departments, will serve as subject matter experts to address questions as needed. In matters where a singular point of oversight is needed, MSE shall serve as the primary governing body.

C. Purpose of program

Although students from many different STEM majors are indeed readily hired into the semiconductor manufacturing workforce, no single major currently offered at OSU actually provides an ideally comprehensive level of preparation compared to the industry's nominal desired educational profile. Therefore, the purpose of this certificate is to help round out the curriculum of any STEM major with curated interdisciplinary courses that will better prepare them for not only entry into the semiconductor manufacturing workforce, but will place them at a competitive advantage for the most desirable career pathways.

1. Method of delivery will be primarily in-person, in accordance with current offerings of the courses within the certificate, including a required laboratory component.
2. All courses included in the certificate, at present, already exist and are currently being offered in-person, with a small number having (or able to have) on-line versions. No delivery mode changes are being made.

D. Methods of delivery

The courses are primarily offered in-person currently. Certain courses may have available on-line offerings, but the overall intent is for in-person learning to the extent possible, especially due to the required laboratory component.

E. Timing

Desired start up is Spring 2024.

F. Goals

The goal is to provide a mechanism for undergraduate students in engineering, math, and other physical sciences to demonstrate competency in semiconductor processing and fabrication methods and technologies to potential employers in addition to the requirements for their BS degrees. The general field of semiconductor processing, fabrication, and manufacturing is, itself, highly multi-disciplinary and nearly impossible to adequately cover within a single academic degree. As such, this certificate is designed to enable the student to round out their degree curriculum, regardless of what actual STEM field they are in, to improve their competitiveness for careers within the domestic semiconductor manufacturing industry. This additional level of preparedness will also be of value to student who intend to go on to graduate education in semiconductor-related fields.

G. Outcomes

Upon completion of the embedded certificate in Semiconductor Processing and Fabrication Technologies learners will be better prepared to:

1. Understand the fundamentals of semiconductors and semiconductor device physics;
2. Understand the basic multidisciplinary science and engineering concepts employed in semiconductor materials processing and device fabrication;
3. Apply the above concepts toward the development, troubleshooting, and/or optimization of semiconductor processes, such as those encountered within semiconductor research and manufacturing environments.

H. Minimum requirements

1. 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.
2. Completion of the certificate requires a minimum of 13 credit hours. Of these, there are three sets of required courses that have been chosen to ensure an adequate curricular background is achieved. The first set is “semiconductor fundamentals,” for which either ECE 3030 Semiconductor Electronic Devices (3 credits) or MATSCEN 3271 Electronic Properties (3 credits) can be taken. The second set includes two categories, “thermodynamics fundamentals” and “engineering probability and statistics.” This set is divided into two categories to address the fact that most STEM students will receive adequate background

within their major of *one* of these categories, but usually not both. The final set is a required "semiconductor processing / cleanroom lab," which will ensure that students received appropriate experiential training. Currently only ECE 5037 Solid State Electronics and Photonics Laboratory (4 credits) satisfies this requirement, but other courses (e.g. in MATSCEN) are currently in development, as are shorter cleanroom-specific training modules. The remaining credits can be chosen from the electives list. In general, equivalent courses (and potentially experiences) not identified herein may also be approved by petition for application to the required sets. Additional courses will be added as they become available (an ongoing process driven by the Intel projects and general alignment of university priorities to meeting the semiconductor workforce demand).

I. Methods of delivery

Number	**Title**	**Online**	**In-Person**	**In-person *or* online**
CBE 2420	Transport Phenomena I		3	
CBE 3421	Transport Phenomena II - Heat Transfer		3	
CBE 3422	Mass Transfer		3	
CBE 3610	Kinetics and Reactor Design		3	
CBE 4624	Chemical Process Dynamics and Control		3	
CBE 5779	Design and Analysis of Experiments		3	
CBE 5780	Molecular Dynamics Simulations		3	
CBE 5790	Modeling and Simulation		3	
CHEM 4310	Physical Chemistry II		3	
CHEM 5520	Nanochemistry		3	
ECE 3030	Semiconductor Device Physics		3	
ECE 5031	Semiconductor Process Technology		3	
ECE 5033	Surfaces and Interfaces of Electronic Materials		3	
ECE 5037	Solid State Electronics and Photonics Laboratory		4	
ECE 5530	Fundamentals of Semiconductors for Microelectronics and Photonics		3	
ISE 2500	Introduction to Manufacturing Engineering		3	
ISE 3200	Linear and Integer Programming		3	
ISE 3400	Production Planning and Facilities Design		4	
ISE 4120	Quality and Reliability Engineering		3	
ISE 4500	Manufacturing Process Engineering		3	
ISE 5110	Design of Engineering Experiments		3	
MATSCEN 2241	Structure and Characterization of Materials		3	
MATSCEN 2251	Thermodynamics of Materials		3	
MATSCEN 3151	Transport Phenomena and Kinetics		3	
MATSCEN 3271	Electronic Properties		3	
MATSCEN 5532	Electronic and Optical Materials Lab		1	

MATSCEN 5552	Nanoscale Synthesis and Processing of Electronic Materials		3	
MATSCEN 5571.72	Electroceramics II (Dielectric, Magnetic, & Optical Ceramics)		1.5	
MATSCEN 5572	Materials for Sustainable Energy Technologies		3	
MATSCEN 5952	Failure Analysis of Materials		3	
MECHENG 3500	Engineering Thermal Sciences		3	
MECHENG 3501	Introduction to Engineering Thermodynamics		3	
MECHENG 3503	Introduction to Fluid Mechanics		3	
MECHENG 3870	Introduction to Measurements and Data Analysis in Mechanical Engineering		3	
MECHENG 4510	Heat Transfer		3	
MECHENG 5539	Applied Computational Fluid Dynamics and Heat Transfer		3	
PHYS 3700	Experimental Physics Instrumentation and Data Analysis Lab		3	
PHYS 5600	Statistical Mechanics		4	
STAT 3470	Introduction to Probability and Statistics for Engineers			3

J. MOU with ODEE

Not required.

K. List of required and elective courses

Alternatives to listed required courses will be considered as long as they provide an equivalent level of instruction on the topic(s) of interest.

1. Required Set 1 (Semiconductor Fundamentals), Pick 1:

ECE 3030 Semiconductor Device Physics (3 credits)

Current Prereqs: ECE 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 1220, 1250, 1620, or 1920H. Prereq or concur: Math 2415 or 2255 or 2177 or 2174.

– 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.

2. Required Set 2 (Thermodynamics Fundamentals or Probability and Statistics), Pick 1 from either category (depending upon existing background):

Thermodynamics

CBE 3509 Chemical Engineering Thermodynamics II (3 credits)

Prereq: CBE 3508, and enrollment in CBE, FABEng, or EngPhysics major; or permission of instructor.

– or –

CHEM 4310 Physical Chemistry II (3 credits)

Prereq: CHEM 4300.

– or –

MATSCEN 2251 Thermodynamics of Materials (3 credits)

Prereq: MSE 2010, Physics 1250 or 1260, Math 1151 or 1161, and Chem 1210 or 1250; and enrollment as MatScEn-BS student; or permission of instructor.

– or –

MECHENG 3500 Engineering Thermal Sciences (3 credits)

Prereq: Math 2174 or 2177 or 2255 (255) or 2415 (415), and Physics 1250 (131).

– or –

MECHENG 3501 Introduction to Engineering Thermodynamics (3 credits)

Prereq: MECHENG 2850 and 2900, and Chem 1210 or 1250; and enrollment as MechEng-BS student; or permission of instructor.

– or –

PHYS 5600 Statistical Mechanics (4 credits)

Prereq: Physics 5500; and Math 2415, 2174, 2255, or 5520H.

Engineering Probability and Statistics

ISE 4120 Quality and Reliability Engineering (3 credits)

Prereq: Stat 3470 and (enrollment in ISE major or Eng. Phys. major)

– or –

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.

3. Required (Processing / Cleanroom Lab), Pick 1:

Additional courses will be added as they become available.

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

Proposed name change: Semiconductor Device Fabrication Lab

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

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

4. Electives:

CBE 2420 Transport Phenomena I (3 credits)

Prereq: CBE 2200, and Math 2173 or 2177 or 2415, and enrollment in CBE, FABEng, or EngPhysics major; or Grad standing; or permission of instructor.

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

Prereq: CBE 2420, or permission of instructor.

CBE 3422 Transport Phenomena III – Mass Transfer (3 credits)

Prereq: CBE 3421, or permission of instructor.

CBE 3610 Kinetics and Reactor Design (3 credits)

Prereq: CBE 3508 or FABEng 3120, and enrollment in CBE, FABEng, or EngPhysics major; or Grad standing; or permission of instructor.

CBE 4624 Chemical Process Dynamics and Control (3 credits)

Prereq: CBE 2523 or 3610, and enrollment in CBE major; or Grad standing, or permission of instructor.

CBE 5779 Design and Analysis of Experiments (3 credits)

Prereq: Jr or Sr standing in CBE.

CBE 5780 Molecular Dynamics Simulations (3 credits)

Prereq: Jr standing or above in Engineering, Chemistry, or Physics; or Grad standing; or permission of instructor.

CBE 5790 Modeling and Simulation (3 credits)

Prereq: Jr, Sr, or Grad standing in CBE.

CHEM 5520 Nanochemistry (3 credits)

Prereq: CHEM 1220, 1620, or 1920H, and permission of instructor.

ECE 5031 Semiconductor Process Technology (3 credits)

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

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

Prereq: ECE 3030, or Grad standing in Engineering, Biological Science, or Math and Physical Sciences.

ECE 5530 Fundamentals of Semiconductors for Microelectronics and Photonics (3 credits)

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

Proposed changes: modify course topics to include more device physics and specifically silicon devices; course change request in progress

ISE 2500 Introduction to Manufacturing Engineering (3 credits)

Prereq: N/A

ISE 3200 Linear and Integer Programming (3 credits)

Prereq: Math 2568 or 2174, and CSE 1222 or 1223 or 1224 or Engr 1281.01H or 1281.02H, and enrollment in ISE or Engineering Physics major. Additional prereq for students enrolled in ISE major: CSE 2112. Additional prereq or co-req for students enrolled in ISE major: ISE 2400.

ISE 3400 Production Planning and Facilities Design (4 credits)

Prereq: ISE 3200, Stat 3470, and enrollment in ISE or Engineering Physics major. Additional prereq for students enrolled in ISE major: ISE 3600.

ISE 4500 Manufacturing Process Engineering (3 credits)

Prereq: Option 1: MechEng 3670. Prereq or concur: MechEng 3503.

Option 2: MechEng 2020 or 2040, and WeldEng 4201 or MechEng 3500 or MatScEn 3151; or permission of instructor.

ISE 5110 Design of Engineering Experiments (3 credits)

Prereq: ISE 4210; or Stat 3470 or equiv, and Grad standing.

MATSCEN 2241 Structure and Characterization of Materials (3 credits)

Prereq: MSE 2010, Physics 1250 or 1260, Math 1151 or 1161, and Chem 1210 or 1250; and enrollment as MatScEn-BS student; or permission of instructor.

MATSCEN 3151 Transport Phenomena and Kinetics (3 credits)

Prereq: MSE 2010 and 2241; and Math 2177 or 2415; or 2174; and enrollment as MatScEn-BS major; or permission of instructor.

MATSCEN 5532 Electronic and Optical Materials Lab (1 credits)

Current Prereqs: MSE2010, MSE2241, MSE3271, or 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 5571.72 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 2241, and 3271 or ECE 2300; and enrollment as MatScEn-BS major; or Grad standing; 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.

MATSCEN 5552 Nanoscale Synthesis and Processing of Electronic Materials (3 credits)

Prereq: MSE 3141 and 3271, or permission of instructor.

MECHENG 3503 Introduction to Fluid Mechanics (3 credits)

Prereq: MECHENG 2850, and 3501 or 3502, and enrollment as MechEng-BS student (No ME pre-majors can enroll in this course); or permission of instructor.

MECHENG 3870 Introduction to Measurements and Data Analysis in Mechanical Engineering (3 credits)

Prereq: Stat 3450 or equiv, and 3260 or 3261, and a second writing course, and enrollment in Mechanical Engineering major; or permission of instructor. Prereq or concur: MECHENG 3503 or 3504.

MECHENG 4510 Heat Transfer (3 credits)

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

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.

L. Length of program compared to similar programs

Comparable.

M. Transfer Credits

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

N. Arranged/Individual Study Courses

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

O. Overlap

100% of the credit hours required for this academic certificate may overlap with the credits required for the student's academic major. We note here that there is some overlap potential with another existing certificate hosted by ECE, *Semiconductor Devices*, exists with this new certificate. While the two certificates are different in their ultimate intents and course requirements, we recognize that there is potential some students may wish to pursue both, and as such up to 7 (of the total 13) credit hours will be allowed to count toward both certificates.

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 in the near-term. We anticipate that interest in this and related certificates will increase as general interest and awareness of the domestic semiconductor manufacturing industry increases, especially within the State of Ohio.

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

This is not expected to happen, but if it does, it is not expected to cause problems – if anything, it would be a good situation to have. There are sufficient numbers of applicable courses available that larger than expected enrollments can be adequately spread out. For the few require courses, lecture class sizes can be increased as needed, or additional sections can be offered (and/or offered more often). Most of the included elective courses generally have modest enrollments (≈20-30), and thus there is plenty of room for growth. The labs may

experience bottlenecks and require additional sections to accommodate large enrollments, which in turn requires additional GTAs. The lab courses, especially in ECE, are already undergoing redevelopment (including cleanroom renovation) in anticipation of larger enrollments, and the department has been promised additional GTA help from the College of Engineering (via recently funded Intel programs for the near future).

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

No, as this will merely represent the current status quo.

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 and/or relevant faculty and space across the associated departments that we can add sections and new courses if there is enough demand.

ECE 5037 expensive and time-consuming to run, and combined with failing equipment, it has not run in recent years. However, the course has now been revamped and modernized, and renovations are underway to the Dreese Lab cleanroom in order to support this course (and potentially others, from ECE and elsewhere); if needed, additional cleanroom resources are available at Nanotech West. The first iteration of the new ECE 5037 is being offered in AU23 (10 students are currently enrolled), after which we anticipate refinement and expansion. It is likely that shorter cleanroom experience/training modules will also be developed for the Dreese Lab cleanroom, which can be used by other courses/departments to provide a wider range of accessible pathways to achieve this important experiential learning. Additionally, other departments are developing new/revamped lab courses that fit the need, which will be added as they become available.

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. We anticipate the addition of new courses that will be developed in response to identified gaps at OSU, but these are not yet even planned.

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

In the near-term, Intel is building 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, as well as a steady flux to address turnover and transitions. Additionally, substantial growth in the semiconductor manufacturing and supply chain industries, both associated with Intel and the industry in general – numerous national and international companies have already committed to expansion into Ohio, at least doubling the workforce needs within the state. Similar activities is happening elsewhere in the Midwest and throughout the US and will continue for years to come. The stark demand for a domestic semiconductor workforce comprised of graduates at all levels is well-documented, and in fact is a major concern of the industry during this rapid growth phase.

B. Duration of demand (long/short term)

Intel is hiring people *now* so they can be trained 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. Furthermore, the substantial growth in the semiconductor manufacturing and supply chain industries, in general, will continue to grow and sustain the demand for a domestic semiconductor workforce for a long time.

C. Ability of other programs to meet demand

Students are already hired by Intel and other semiconductor industry entities from a wide range of STEM fields due to their general technical skills. Although some areas (e.g. MSE, CBE, ECE, MAE) are more directly relevant to semiconductor manufacturing than others, no single major curriculum meets the desired educational profile of the semiconductor industry 100%, and some area require even further additional training than others. This certificate will help to provide fill the fundamental gaps for students from any STEM major, whether they come from disciplines with typically little to no semiconductor focus or from those with significant semiconductor content; all will be made much more highly competitive in the job market and the student-to-workforce transition will be made smoother. This certificate is designed with the existence of world-class faculty and specialized courses in semiconductor materials, processing, and devices within the Departments of Electrical and Computer Engineering and Materials Science and Engineering in mind, with further highly relevant courses and expertise from other more manufacturing focused departments, including Chemical Engineering, Mechanical Engineering, and Industrial Systems Engineering.

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

A. Overlap with other programs or departments

This certificate is interdisciplinary in nature and designed to complement the curriculum of any STEM major. As such, a certain degree of overlap with many Engineering and Natural Sciences programs/departments is both expected, unavoidable, and indeed necessary to ensure a truly multi-disciplinary slate of courses are available to meet the need of student. When applied mindfully, this interdisciplinary certificate will provide an excellent value proposition for the enrolled students, beyond what they could obtain within the confines of their major alone.

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

Many universities, both in Ohio and across the US, are currently in the process of developing similar certificates and programs in response to the rapidly growth domestic semiconductor workforce needs. Given the substantial size of the current semiconductor workforce shortfall, duplication is in fact a necessity. Beyond that, it is imperative that OSU can compete in this space or we risk losing students to those other institutions, or worse yet, graduating students who are underprepared for the careers they seek.

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

Similar programs, for example at U. Cincinnati, U. Akron, and U. Dayton, etc., are in similar states as this (i.e. in development or just started), and as such there is no sufficient data for comparison. The closest for comparison would be Arizona State University, which has a long-running history with Intel and their local manufacturing facility. The program there is highly successful and has served as a role model of sorts for our own development efforts here.

MSE Approval

Grassman, Tyler

From: Sumption, Michael
Sent: Wednesday, August 16, 2023 3:37 PM
To: Westhoff, Kami; Grassman, Tyler; Niezgoda, Steve
Cc: Locke, Jenifer; Beach, Elvin; Chowdhury, Enam; Brown, Jonathan; Phillips, David
Subject: Re: Important Undergrad studies item

Tyler,

OK, we have at least a consensus here, without further comment, this is "approved".

Elvin, the idea to make lab classes worth more than 1 credit is a longstanding item (and has of course merit!), but we can't because otherwise the credits to degree are too large. I personally don't advocate changing that, even in any kind of curriculum review process, which in fact I hope our group will take on early this fall.

Mike Sumption

Mike Sumption
Professor and Associate Director
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SuTC (Superconducting Technology Center)
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From: Westhoff, Kami <westhoff.11@osu.edu>
Sent: Wednesday, August 16, 2023 1:13 PM
To: Grassman, Tyler <grassman.5@osu.edu>; Niezgoda, Steve <niezgoda.6@osu.edu>; Sumption, Michael <sumption.3@osu.edu>
Cc: Locke, Jenifer <locke.121@osu.edu>; Beach, Elvin <beach.110@osu.edu>; Chowdhury, Enam <chowdhury.24@osu.edu>; Brown, Jonathan <brown.4972@osu.edu>; Phillips, David <phillips.176@osu.edu>
Subject: Re: Important Undergrad studies item

Tyler,
Good to know, thank you for the clarification. I really like that anyone can complete these. I don’t mind advising them, I have a smaller roster than the ECE advisers anyway.
Best,
Kami

From: Grassman, Tyler <grassman.5@osu.edu>
Date: Wednesday, August 16, 2023 at 12:54 PM
To: Westhoff, Kami <westhoff.11@osu.edu>, Niezgoda, Steve <niezgoda.6@osu.edu>, Sumption, Michael <sumption.3@osu.edu>
Cc: Locke, Jenifer <locke.121@osu.edu>, Beach, Elvin <beach.110@osu.edu>, Chowdhury, Enam <chowdhury.24@osu.edu>, Brown, Jonathan <brown.4972@osu.edu>, Phillips, David <phillips.176@osu.edu>
Subject: RE: Important Undergrad studies item

Kami,

Yeah, we (Siddharth and I) were actually hoping to do a sort of webinar with all the STEM advisors to explain everything, but again, the ECE folks jumped ahead. At present, the now-approved certificates that you've been informed about are basically ECE-only; non-ECE students can take them, in which case they'll basically be like a minor, but it'll require taking 4 extra courses. This new certificate (and the ones that we will be expanding) will be interdisciplinary and hopefully more equally accessible to everyone. I don't know the specifics of how these things get advised/supported, but I asked if ECE could handle this as lead since they're already doing it for the others, but maybe there's some way to share the load (maybe split depending on student dept or something?). I guess I would be the main faculty POC; certainly for MSE, but I guess probably others as needed.

As for the GPA thing… To be honest, I just copied a lot of the general fodder from ECE's applications from last year, this included. I don't know what the genesis of this number is. Probably just meant to be inclusive. I would assume any student on probation wouldn't actually try tacking on even more work, right?

Ultimately this cert (and all of the UG certs we've been doing so far) are of the *embedded* type, which means the students need to be enrolled in an actual program at OSU. Stand-alone versions didn't really make sense. So any associates-level students will basically be regular transfers.

-Tyler

From: Westhoff, Kami <westhoff.11@osu.edu>
Sent: Wednesday, August 16, 2023 12:43 PM
To: Grassman, Tyler <grassman.5@osu.edu>; Niezgoda, Steve <niezgoda.6@osu.edu>; Sumption, Michael <sumption.3@osu.edu>
Cc: Locke, Jenifer <locke.121@osu.edu>; Beach, Elvin <beach.110@osu.edu>; Chowdhury, Enam <chowdhury.24@osu.edu>; Brown, Jonathan <brown.4972@osu.edu>; Phillips, David <phillips.176@osu.edu>
Subject: Re: Important Undergrad studies item

Hi All,
I was going to mention the new certificates from ECE, they have already advertised it to advisers. I also have concerns about the entry GPA being 1.7- typically most programs require students to be at a 2.0 (in good standing) to enter. Most student below 2.0 are on probation or have been dismissed.
Also, just as an awareness, Associates programs at OSU are only offered at the regional campuses.
I assume I will advise this? Will there be a faculty to support decisions?

Otherwise, I love it and it looks great!
I'm really glad this is happening, I think it will be a great draw for our program.
Best,
Kami

THE OHIO STATE UNIVERSITY

Kami Westhoff, MFA
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Materials Science and Engineering & Welding Engineering
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she/her/hers
To schedule an appointment:
https://buckeyes.campus.eab.com/pal/j4Z6PDvmsH

Drop-In Hours Every Week:
Friday 2-4 pm
Zoom Link:
https://osu.zoom.us/j/3857436155
password: MSEWE

Dennis Learning Center , Student Wellness Center, Counseling and Consultation Services, & Disability Services
Looking for a different resource? Let me know and I'd be happy to help you!

APPLY TO GRADUATE HELPFUL ADVISING INFO

From: Grassman, Tyler <grassman.5@osu.edu>
Date: Wednesday, August 16, 2023 at 11:50 AM
To: Niezgoda, Steve <niezgoda.6@osu.edu>, Sumption, Michael <sumption.3@osu.edu>, Westhoff, Kami <westhoff.11@osu.edu>
Cc: Locke, Jenifer <locke.121@osu.edu>, Beach, Elvin <beach.110@osu.edu>, Chowdhury, Enam <chowdhury.24@osu.edu>, Brown, Jonathan <brown.4972@osu.edu>, Phillips, David <phillips.176@osu.edu>
Subject: RE: Important Undergrad studies item

Thanks Steve. I kind of tried to address the "tie to manufacturing" issue in Outcome #3: *Apply the above concepts toward the development, troubleshooting, and/or optimization of semiconductor processes, such as those encountered within semiconductor research and manufacturing environments*. The "theory" being we want them to understand the fundamentals (#1 and #2) and then understand how they apply to manufacturing/research (#3). But if this isn't obvious or good enough, let me know and I can certainly rewrite!

-Tyler

From: Niezgoda, Steve <niezgoda.6@osu.edu>
Sent: Wednesday, August 16, 2023 11:47 AM
To: Sumption, Michael <sumption.3@osu.edu>; Westhoff, Kami <westhoff.11@osu.edu>; Grassman, Tyler <grassman.5@osu.edu>
Cc: Locke, Jenifer <locke.121@osu.edu>; Beach, Elvin <beach.110@osu.edu>; Chowdhury, Enam <chowdhury.24@osu.edu>; Brown, Jonathan <brown.4972@osu.edu>; Phillips, David <phillips.176@osu.edu>
Subject: Re: Important Undergrad studies item

I also strongly support. This seems well done and thought out.

My only comment is really kind of nit-picky: Outcome #2 should specifically use the word "manufacturing"

Maybe
Understand the basic multidisciplinary science and engineering concepts employed in semiconductor manufacturing including materials processing and device fabrication.

It ties the outcomes to the certificate title in a more coherent way.

Steve

From: Sumption, Michael <sumption.3@osu.edu>
Date: Wednesday, August 16, 2023 at 10:50 AM
To: Westhoff, Kami <westhoff.11@osu.edu>, Grassman, Tyler <grassman.5@osu.edu>
Cc: Niezgoda, Steve <niezgoda.6@osu.edu>, Locke, Jenifer <locke.121@osu.edu>, Beach, Elvin <beach.110@osu.edu>, Chowdhury, Enam <chowdhury.24@osu.edu>, Brown, Jonathan <brown.4972@osu.edu>, Phillips, David <phillips.176@osu.edu>
Subject: Important Undergrad studies item

Colleagues,

We have an important item of business before the start of Autumn 2023. (I know the USG committee will change slightly in fall, but most of you will continue..)

Tyler Grassman and Siddharth Rajan have developed a new certificate (its kind of like a minor, but slightly different) for undergrad students in MSE and ECE on semiconductor processing. This certificate would be jointly housed by ECE and MSE.

We need to give our approval for this to move forward, and we want to do it quickly (assuming we agree), so that they can implement this in this coming semester.

I include it here, please peruse.

I support this strongly, and think it's a no brainer. But, if anybody sees an issue please comment.

Let's try to give Tyler (copied) feedback today/tomorrow if we can.

thanks

Mike Sumption

Mike Sumption
Professor and Associate Director
CSMM (Center for Superconducting and Magnetic Materials), MSE
SuTC (Superconducting Technology Center)
Fontana Laboratory
Materials Science Department
The Ohio State University
Columbus, OH 43210
Phone: 614-688-3684
Fax: 614-292-1537

ECE Approval

Grassman, Tyler

From: Anderson, Betty Lise
Sent: Wednesday, August 23, 2023 3:45 PM
To: Grassman, Tyler
Cc: Rajan, Siddharth
Subject: Re: New interdisciplinary semiconductor certificate application (from Intel curriculum project)

Tyler- after all that, I completely forgot to invite you. But, sure, we approve of your certificate proposal. I think we should specify that students can do both certificates, and double- count some number of credits (I suggest 7, so that would be two courses) to both certificates. We have multiple graduate certificates and that's what we're doing there.

Also, In section O for Overlap, the university changed the rules and now you can double-count ALL certificate courses with major courses. I recommend you make that change before submitting, because I found out the hard way that they won't let you change it midstream. I had to wait for the entire 10 certificates to be approved, the submit revisions for all 10. Then you could add the statement about overlap between certificates in the same section. That is, 100% of courses can count toward a certificate and a major, 7 out of 13 credits can count from one certificate to the other. We think a bunch of our students would do both, because all those non-ECE courses can be counted as Directed Electives for our students, so they can count toward their majors also. It's free.

Here is the language we're using in our revised grad certificate proposals:
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.

> We would be happy to be the de facto "home" for both certificates. All that would mean is that our advisors would add it to students' stacks and they know to do that. They indicated they would be happy to do this so they could easily track numbers of who's doing which ones. But we don't feel strongly about it. An our advisors would be happy to teach the advisors in other majors how to do it.

THE OHIO STATE UNIVERSITY

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205 Dreese Laboratory | 2015 Neil Avenue Columbus, OH 43210
614-292-1323 Office | 614-292-7596 Fax
anderson.67@osu.edu
http://www.ece.osu.edu/~anderson/

From: Grassman, Tyler <grassman.5@osu.edu>
Date: Monday, August 14, 2023 at 1:21 PM
To: Anderson, Betty Lise <anderson.67@osu.edu>
Cc: Rajan, Siddharth <rajan.21@osu.edu>
Subject: RE: New interdisciplinary semiconductor certificate application (from Intel curriculum project)

Yes, I'd be happy to give the pitch. Thanks!

-Tyler

From: Anderson, Betty Lise <anderson.67@osu.edu>
Sent: Monday, August 14, 2023 1:20 PM
To: Grassman, Tyler <grassman.5@osu.edu>
Cc: Rajan, Siddharth <rajan.21@osu.edu>
Subject: Re: New interdisciplinary semiconductor certificate application (from Intel curriculum project)

Ooh, I like the idea of double-counting so one could get both certificates. I do still need to run it by the curriculum committee; would you be willing to present you proposal? Not like I've set up a meeting time yet but I guess tha's next on the agenda for me this afternoon. 😊

THE OHIO STATE UNIVERSITY

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From: Grassman, Tyler <grassman.5@osu.edu>
Date: Monday, August 14, 2023 at 1:15 PM
To: Anderson, Betty Lise <anderson.67@osu.edu>
Cc: Rajan, Siddharth <rajan.21@osu.edu>
Subject: RE: New interdisciplinary semiconductor certificate application (from Intel curriculum project)

Betty Lise,

My apologies that we accidentally kept you in the dark. I guess I had assumed that Siddharth had informed you we were working on this, but I don't know that I ever had any real reason to assume as much! My bad. We absolutely used the certs that you set up as inspiration and a starting point, though.

Anyway, as for the existing Semiconductor Devices cert, I would definitely recommended adding the extra courses Siddharth and I identified, if that's possible, as laid out in the "updated" application I sent you.

But for this new one it is intended to be considerably more interdisciplinary and accessible for basically any STEM major; this is important given that Intel's generally preferred hiring pool for process engineers are from ChemE, Chem, and MSE. Thus this certificate is much more processing/fabrication/manufacturing oriented. You'll notice there aren't really advanced devices courses in the electives mix, but more things related to processing or manufacturing, as well as an additional focus on things like fundamental thermodynamics and statistics. The lab requirement is narrower in that it *mandates* hands-on processing/cleanroom activities, which means ECE 5037 is currently the only class that fits that bill (hopefully there will be more in the near future). So, ultimately there is *some* overlap, but with different intended outcomes/objectives, I think it's best to leave them as separate certificates. Regarding overlap, maybe we could just say that no more than 7 credits / 2 courses can be used for both, that way they'll have to take at least two extra courses (similar to overlap vs. major courses)?

-Tyler

From: Anderson, Betty Lise <anderson.67@osu.edu>
Sent: Monday, August 14, 2023 1:01 PM
To: Grassman, Tyler <grassman.5@osu.edu>
Cc: Rajan, Siddharth <rajan.21@osu.edu>
Subject: Re: New interdisciplinary semiconductor certificate application (from Intel curriculum project)

Hi,Tyler,

This is the first I've heard of your proposal certificate, so let me think this through. I have no objection. It seems like there is a lot of overlap between them, only yours is way more extensive. We never intended to make our so ECE-centric, just wanted to get the ball rolling as you noted. My first reaction is that maybe we should just add all those new courses you suggested to the existing certificate. Trouble is, I already have a proposed change in the works so another change would have to wait for the first one to complete. On the other hand, just adding courses makes everyone happy so would it be a slam dunk to get approved quickly.

But your proposed certificate is more manufacturing- oriented, or at least can be, depending on what students want to emphasize. So should it be a separate certificate? I don't know. I can see it both ways. I propose we bring it to the ECE Curriculum Committee (and invite you) and talk it through. I am happy with either outcome.

THE OHIO STATE UNIVERSITY

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From: Grassman, Tyler <grassman.5@osu.edu>
Date: Monday, August 14, 2023 at 12:18 PM
To: Anderson, Betty Lise <anderson.67@osu.edu>
Cc: Rajan, Siddharth <rajan.21@osu.edu>
Subject: RE: New interdisciplinary semiconductor certificate application (from Intel curriculum project)

Betty Lise,

One additional thing to note is that the Intel curriculum project and the curriculum development sub-committee thereof wanted to expand the Semiconductor Devices certificate course listing to make it a bit more interdisciplinary and/or accessible to non-ECE students. This was really the goal from the beginning, but you all (ECE) hit the ground running — especially compared to the lack of organization in the original Intel project — and beat us to the punch. But the committee, and Siddharth and myself, have spent some time trying to identify courses outside of ECE that would still fit into the devices and device design realm that would be useful for a BS student going into the semiconductor workforce. I'm attaching a revised application write-up that includes these changes (although they are not explicitly highlighted, sorry about that). Ultimately it's not a huge change, just a handful of additional courses from MATSCE, CBE, MECHENG, ISE, and STAT. I guess some of these might end up creating additional overlap between the two certs, especially with respect to the required

courses, but I think it's not too bad. Not sure if we would need to go through and get confirmation from the departments on all these, too, to make it official, though…?

-Tyler

CBC Approval

Grassman, Tyler

From: Jackman, Jane
Sent: Friday, September 8, 2023 4:04 PM
To: Grassman, Tyler; Goldberger, Joshua
Subject: RE: Concurrence request for new interdisciplinary semiconductor certificate (from Intel curriculum project)

Dear Tyler,

Thank you for your patience. The curriculum committee for the Department of Chemistry and Biochemistry has reviewed the Department of Engineering – Semi Conductor Certificate program and provide our concurrence with this email. There were no objections to the program presented.

The following changes to prerequisites for ECE 3030 were recommended:

Proposed new prereqs: Physics 1251, 1261, or both 1240 and 1241; and Chem 1220, 1620, 1920H, or 1250. Prereq or concur: Math 2415 or 2174.

The following concern was discussed by the committee, and we would appreciate additional clarity:

The math courses for a Chemistry BS major are different than the math prerequisites listed for ECE 3030.

BS in Chemistry: Math 2415 (Ordinary and Partial Differential Equations) OR Math 2255 (Differential Equations and their Applications) OR Math 2177 (Math Topics for Engineers)

Prerequisites for ECE 3030: Math 2415 (Ordinary and Partial Differential Equations) OR Math 2174 (Linear Algebra and Differential Equations for Engineers).

We are wondering it if would be appropriate to allow Math 2255 and/or 2177 to also be listed as an alternate math prerequisite for ECE 3030? Our committee is not familiar with the content of ECE 3030 to confirm this would be the best plan. Nonetheless, if these courses are not added as approved pre-reqs, we would like clarity about whether either or both these courses would likely be allowed in place of the listed math pre-reqs, so that we can best advise Chem major students interested in pursuing the certification.

We appreciate your work to develop a program that will benefit many students, including our Chemistry majors. Please let us know if there are any additional questions.

Best,
Jane

Dr. Jane E. Jackman
Professor and Vice Chair for Undergraduate Studies
Department of Chemistry and Biochemistry
Vice Chair Office: 110 Celeste Lab
Research Office: 740 Biological Sciences
Mailing Address:

Department of Chemistry and Biochemistry
484 W. 12th Avenue
Columbus, OH 43210
Phone: 614-247-8097
She/her pronouns

From: Grassman, Tyler <grassman.5@osu.edu>
Sent: Wednesday, September 6, 2023 2:49 PM
To: Jackman, Jane <jackman.14@osu.edu>; Goldberger, Joshua <goldberger@chemistry.ohio-state.edu>
Subject: RE: Concurrence request for new interdisciplinary semiconductor certificate (from Intel curriculum project)

Jane,

Following up on this concurrence request. I've been told that the College of Engineering Curriculum Affairs Committee, who is the first step in getting this certificate approved, is meeting next week, and thus I need to get the full application package to them ASAP. Thank you very much.

Regards,
Tyler Grassman

From: Jackman, Jane <jackman.14@osu.edu>
Sent: Thursday, August 17, 2023 7:16 PM
To: Grassman, Tyler <grassman.5@osu.edu>; Goldberger, Joshua <goldberger@chemistry.ohio-state.edu>
Subject: RE: Concurrence request for new interdisciplinary semiconductor certificate (from Intel curriculum project)

Hi Tyler and Josh-

Thanks for the responses- I had missed the change in pre-reqs for the other course (ECE 3030) so I see that it will work well.

I will look into getting this through our curriculum committee as soon as I can and get back to you, Tyler. I assume it will be fine, though. If you do find out a specific date you need it, please let me know.

Thanks,
Jane

Dr. Jane E. Jackman
Professor and Vice Chair for Undergraduate Studies
Department of Chemistry and Biochemistry
Vice Chair Office: 110 Celeste Lab
Research Office: 740 Biological Sciences
Mailing Address:
Department of Chemistry and Biochemistry
484 W. 12th Avenue
Columbus, OH 43210
Phone: 614-247-8097
She/her pronouns

From: Grassman, Tyler <grassman.5@osu.edu>
Sent: Thursday, August 17, 2023 9:59 AM

To: Goldberger, Joshua <goldberger@chemistry.ohio-state.edu>; Jackman, Jane <jackman.14@osu.edu>
Subject: RE: Concurrence request for new interdisciplinary semiconductor certificate (from Intel curriculum project)

Jane,

Thank you for the response and support. As for an actual date, I don't know that… I'm just told by our the vice provost that it's "soon." Sorry about that. I know other departments have just been sending it around internally to form their response.

As for the path for Chemistry students (and other non-engineering students)… Josh is right on the money. Our goal in putting this together was to create as even of a playing field as possible with low-barrier pathways for student coming from any STEM field. As someone who did just that (my BS was in chemistry, MS/PhD in materials science), I think it's actually been a benefit to my understanding of the semiconductor field. But, of course, this is all easier said than done, but what I think we've managed to do is have enough relevant courses from a enough different disciplines that just about any student *should* be able to put together a path that allows them to snag the certificate with only two additional courses. Pre-reqs are always a bit of a pain because in order to officially change them we're supposed to actually put in an approval request through the college and yadda yadda. But we can *always* waive a pre-req; for MSE 3271, for example, the main thing would be that students have some understanding of crystal structures. So for CBC majors that could be coming from inorganic chem, or maybe even aspects of gen chem or p-chem (depending on the specific topics covered). I know I put it in there, but perhaps it would be helpful to put in additional explicit notes that pre-req requirements for the required courses (at least required *lecture* courses) can be waived if the student can show they've got something that covers the relevant background.

-Tyler

From: Goldberger, Joshua <goldberger@chemistry.ohio-state.edu>
Sent: Thursday, August 17, 2023 8:58 AM
To: Jackman, Jane <jackman.14@osu.edu>; Grassman, Tyler <grassman.5@osu.edu>
Subject: Re: Concurrence request for new interdisciplinary semiconductor certificate (from Intel curriculum project)

Hello Jane,

I believe you may be misreading the courses in the certificate program

For the four course certificate, students will be required to take

1) one required semiconductor fundamentals course (either ECE 3030 or MATSCEN 3271)
2) one required thermodynamics course (likely Chem 4310, for CBC majors).
3) The one required processing/cleanroom course (ECE 5037)
4) And one elective (likely Chem 5520 for CBC majors)

For the semiconductor fundamentals course, students can either choose ECE 3030 or MATSCEN 3271. The MATSCEN 3271 has a MATSCEN prerequisite, but ECE has changed the prerequisites on the ECE 3030 and ECE 5037 in order to greatly facilitate non-ECE majors to participate in the program.

ECE 3030 has the following basic prerequisites; Physics 1251, 1261, or both 1240 and 1241; and Chem 1210, 1220, or 1250. Prereq or concur: Math 2415 or 2174.

Basically, I envision all Chem majors interested in this certificate would take ECE 3030 and ECE 5037.

Josh

Joshua Goldberger, PhD Professor
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Associate Editor, *Science Advances*

https://research.cbc.osu.edu/goldberger.4/

From: Jackman, Jane <jackman.14@osu.edu>
Date: Wednesday, August 16, 2023 at 4:55 PM
To: Grassman, Tyler <grassman.5@osu.edu>
Cc: Goldberger, Joshua <goldberger@chemistry.ohio-state.edu>
Subject: RE: Concurrence request for new interdisciplinary semiconductor certificate (from Intel curriculum project)

Hi Tyler,

This looks like a great option for our students and I'm sure we can support this.

I do have an issue in that our curriculum committee is not set to meet right away- you said you have a short clock, but what is the actual date you need this concurrence by?

The question that I think my committee might have is about the currently required set 1 (semiconductor fundamentals) courses- if I understand what you are listing now, the course that CHEM students would be eligible for still requires an additional MSE course as a pre-req, so there is not a direct route to the certificate for non-engineering students. I understand that you would be trying to use existing classes and creating new ones may take time, but are there any plans to create a semiconductor fundamentals course that would be more accessible to students outside of engineering without taking additional pre-reqs?

If you can answer these questions for me, I will see what I can do to get this done more quickly.

Thanks,
Jane

Dr. Jane E. Jackman
Professor and Vice Chair for Undergraduate Studies
Department of Chemistry and Biochemistry
Vice Chair Office: 110 Celeste Lab
Research Office: 740 Biological Sciences
Mailing Address:
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From: Grassman, Tyler <grassman.5@osu.edu>
Sent: Wednesday, August 16, 2023 1:24 PM
To: Jackman, Jane <jackman.14@osu.edu>
Cc: Goldberger, Joshua <goldberger@chemistry.ohio-state.edu>
Subject: Concurrence request for new interdisciplinary semiconductor certificate (from Intel curriculum project)
Importance: High

Jane,

As part of one of the Intel-funded projects that OSU is involved in, an interdisciplinary committee of engineering and science departments (Josh has been a valued participant) has been working on developing some new certificates that students from various departments can take to better prepare them for the semiconductor manufacturing workforce. ECE has already established a few focused certificates; our committee has been concentrating on both expanding those to be more interdisciplinary (and generally more useful) and to creating new interdisciplinary ones altogether. The first of these latter I am attaching here, concerning Semiconductor Process and Manufacturing Technology. Because we are proposing to include a couple Chemistry courses within the electives list, we need concurrence from your curriculum committee as part of our submission to the college. We don't expect the student loan to be huge, and there are enough courses that they will be fairly spread out amongst the different departments. If anything, having courses included is almost more of a convenience to a given department's students since they can double-count two courses for their major.

Anyway, in order to submit this for approval review we need "letters of concurrence" from the departments' curriculum committees (although I'm told an email is fine); according to our provost the chair/POC for this role in Chemistry is you. Hopefully that is correct (if not, please forward to whomever is the correct individual). If you have any questions, comments, edits, … please let me know. Unfortunately we've got a bit of a short fuse in order to get this submitted in time for the college committee to review it this semester, so the sooner we get this done the better (sorry for the rush).

Thanks,
Tyler Grassman

Tyler J. Grassman
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CBE Approval

Grassman, Tyler

From: Wyslouzil, Barbara
Sent: Wednesday, September 6, 2023 3:07 PM
To: Grassman, Tyler; Endres, Brian; Brunelli, Nick
Subject: Re: Concurrence request for new interdisciplinary semiconductor certificate (from Intel curriculum project)

Dear Tyler,

CBE provides concurrence for the Embedded Certificate in Semi-conductor Process and Manufacturing Technology.

Sincerely,
Barbara Wyslouzil
CBE Curriculum Chair.

From: Grassman, Tyler <grassman.5@osu.edu>
Sent: Wednesday, September 6, 2023 2:50 PM
To: Brunelli, Nick <brunelli.2@osu.edu>; Wyslouzil, Barbara <wyslouzil.1@osu.edu>; Endres, Brian <endres.10@osu.edu>
Subject: RE: Concurrence request for new interdisciplinary semiconductor certificate (from Intel curriculum project)

All,

Following up on this concurrence request. I've been told that the College of Engineering Curriculum Affairs Committee, who is the first step in getting this certificate approved, is meeting next week, and thus I need to get the full application package to them ASAP. Thank you very much.

Regards,
Tyler Grassman

From: Brunelli, Nick <brunelli.2@osu.edu>
Sent: Wednesday, August 16, 2023 2:06 PM
To: Wyslouzil, Barbara <wyslouzil.1@osu.edu>; Endres, Brian <endres.10@osu.edu>
Cc: Grassman, Tyler <grassman.5@osu.edu>
Subject: FW: Concurrence request for new interdisciplinary semiconductor certificate (from Intel curriculum project)

Dear all,
This is the forwarded version of the message with the attachment.

Sincerely,
Nick

From: Grassman, Tyler <grassman.5@osu.edu>
Date: Wednesday, August 16, 2023 at 1:03 PM
To: Brunelli, Nick <brunelli.2@osu.edu>

Subject: Concurrence request for new interdisciplinary semiconductor certificate (from Intel curriculum project)

Nick,

We've finally completed the application for the new undergrad Semiconductor Process and Manufacturing Technology certificate that we've been working on. Thanks again for all the help! I was getting ready to submit it when I was told by Dave Tomasko that we had to get written approval from the departments whose courses we're using. Specifically he says "letters of concurrence," and that an email from the curriculum committee chair for the department is fine. According to him that's you for CBE! So I've attached the cert application here. You know the genesis behind it, but if you have any questions, comments, edits, whatever, please let me know. Unfortunately we've got a bit of a short fuse in order to get this submitted in time for the college committee to review it this semester, so the sooner we get this done the better (sorry for the rush).

Thanks,
Tyler Grassman

ISE Approval

Grassman, Tyler

From: Sommerich, Carolyn
Sent: Wednesday, August 16, 2023 5:30 PM
To: Grassman, Tyler
Cc: Bayraksan, Guzin; Owens, Tracy L.
Subject: RE: Concurrence request for new interdisciplinary semiconductor certificate (from Intel curriculum project)

Hello Tyler,

ISE provides concurrence for this certificate program.

I do see a gap, though, in that there are no courses having to do with workplace safety listed in the elective course section of the proposal.
Even though fab operations are often thought of as “clean”, there are hazards in those work environments, just as in any manufacturing setting.
Each fall, ISE offers ISE 5640 - Occupational Safety: Analysis and Design of Work Environments

From the syllabus…
The first canon of the ABET Code of Ethics of Engineers states that "Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties".

- The objective of this survey course is to help you become a better engineer, designer, or other professional with safety-related responsibilities and a more valuable employee by raising your awareness of the vital role of engineering in contributing to safer workplaces, through design and choice of products, equipment, facilities, work methods, and processes. In this course, you will be encouraged to take a systems (holistic) view of safety. You will learn about various types of occupational hazards and risk-reducing interventions (engineering and other types). You will learn about current approaches to hazard recognition and analysis and accident/incident investigation; current thinking about the role of human error in accidents; human factors aspects of the design of warnings; safety research methods; safety management; and more. Throughout the course, you will have the opportunity to discuss these topics with practicing safety experts from the Central Ohio area and beyond.

Please let me know if you will considering adding this course.

Thank you,
Carolyn

****

Carolyn M. Sommerich, PhD, CPE, FHFES *(she/her/hers)*
President, Human Factors and Ergonomics Society (https://www.hfes.org/)
Professor
Engineering Laboratory for Human Factors/Ergonomics/Safety
The Ohio State University
Dept. of Integrated Systems Engineering
1971 Neil Ave., Rm. 210 Baker Systems
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fax: 614-292-7852
https://u.osu.edu/sommerich.1/

From: Grassman, Tyler <grassman.5@osu.edu>
Sent: Wednesday, August 16, 2023 1:31 PM
To: Sommerich, Carolyn <sommerich.1@osu.edu>
Cc: Bayraksan, Guzin <bayraksan.1@osu.edu>; Owens, Tracy L. <owens.1337@osu.edu>
Subject: RE: Concurrence request for new interdisciplinary semiconductor certificate (from Intel curriculum project)

Just realized I forgot the attachment! Here it is.

-Tyler

From: Grassman, Tyler
Sent: Wednesday, August 16, 2023 1:18 PM
To: Sommerich, Carolyn <sommerich.1@osu.edu>
Cc: Bayraksan, Guzin <bayraksan.1@osu.edu>; Owens, Tracy L. <owens.1337@osu.edu>
Subject: Concurrence request for new interdisciplinary semiconductor certificate (from Intel curriculum project)
Importance: High

Carolyn,

As part of one of the Intel-funded projects that OSU is involved in, an interdisciplinary committee of engineering and science departments (Guzin and Tracy have both been valued participants) has been working on developing some new certificates that students from various departments can take to better prepare them for the semiconductor manufacturing workforce. ECE has already established a few focused certificates; our committee has been concentrating on both expanding those to be more interdisciplinary (and generally more useful) and to creating new interdisciplinary ones altogether. The first of these latter I am attaching here, concerning Semiconductor Process and Manufacturing Technology. Because we are proposing to include a few ISE, as suggested by Guzin and Tracy (and they do fit nicely into the needs of the certificate), we need concurrence from your curriculum committee as part of our submission to the college. We don't expect the student loan to be huge, and there are enough courses that they will be fairly spread out. Having a department's courses included is almost more of a convenience to that department's students since they can double-count two courses for their major.

Anyway, Dave Tomasko says we need "letters of concurrence," but that an email is fine, and that for ME the chair/POC is you. Hopefully that is correct (if not, please forward to whomever is the correct individual). If you have any questions, comments, edits, … please let me know. Unfortunately we've got a bit of a short fuse in order to get this submitted in time for the college committee to review it this semester, so the sooner we get this done the better (sorry for the rush).

Thanks,
Tyler Grassman

Tyler J. Grassman
Associate Professor
The Ohio State University
Dept. of Materials Science & Engineering
Dept. of Electrical & Computer Engineering
4012 Fontana Lab
140 W. 19th Ave.
Columbus, OH 43210

MAE Approval

Grassman, Tyler

From: Srinivasan, Manoj
Sent: Wednesday, August 23, 2023 7:05 PM
To: Grassman, Tyler; Mazumder, Sandip
Subject: Re: Concurrence request for new interdisciplinary semiconductor certificate (from Intel curriculum project)

Hi Tyler (cc-Sandip)

MAE is happy to provide concurrence for this certificate.

Almost all faculty that responded said this is a good idea or just concurred. No real concerns.

Minor remarks: One faculty member wondered if the ME6515/BME 5663 (cross-listed courses) could/should be included in this list of courses. But I assume Sandip and the rest of the team has already reviewed this and decide to leave it out -- as apparently the course was in an early draft … My own question was about potential inclusion of robotics/ automation courses in the list of electives (although most of them are quite broader than specifically about manufacturing), but Sandip said that the 'robotics and automation minor' is separately being pitched to Intel and doesn't belong here, and that you have largely finalized the list of courses you want to include in this certificate.

So, all seems good to us.

Thank you!
Manoj

From: Grassman, Tyler <grassman.5@osu.edu>
Sent: Wednesday, August 16, 2023 1:14 PM
To: Srinivasan, Manoj <srinivasan.88@osu.edu>
Cc: Mazumder, Sandip <mazumder.2@osu.edu>
Subject: Concurrence request for new interdisciplinary semiconductor certificate (from Intel curriculum project)

Manoj,

As part of one of the Intel-funded projects that OSU is involved in, an interdisciplinary committee of engineering and science departments (Sandip included) has been working on developing some new certificates that students from various departments can take to better prepare them for the semiconductor manufacturing workforce. ECE has already established a few focused certificates; our committee has been concentrating on both expanding those to be more interdisciplinary (and generally more useful) and to creating new interdisciplinary ones altogether. The first of these latter I am attaching here, concerning Semiconductor Process and Manufacturing Technology. Because we are proposing to include a handful of MECHENG courses, as suggested by Sandip (and they do fit nicely into the needs of the certificate), we need concurrence from your curriculum committee as part of our submission to the college.

Specifically, Dave Tomasko says we need "letters of concurrence," but that an email is fine, and that for ME the chair/POC is you. Hopefully that is correct (if not, please forward to whomever is the correct individual). If you have any questions, comments, edits, … please let me know. Unfortunately we've got a bit of a short fuse

in order to get this submitted in time for the college committee to review it this semester, so the sooner we get this done the better (sorry for the rush).

Thanks,
Tyler Grassman

Tyler J. Grassman
Associate Professor
The Ohio State University
Dept. of Materials Science & Engineering
Dept. of Electrical & Computer Engineering
4012 Fontana Lab
140 W. 19th Ave.
Columbus, OH 43210

Office: 614-688-1704
Email: grassman.5@osu.edu
URL: https://engineering.osu.edu/people/grassman.5

PHYS Approval

Grassman, Tyler

From: Humanic, Thomas
Sent: Wednesday, August 16, 2023 1:31 PM
To: Grassman, Tyler
Cc: Kawakami, Roland K.; Humanic, Thomas
Subject: Re: Concurrence request for new interdisciplinary semiconductor certificate (from Intel curriculum project)

Dear Tyler,

The Department of Physics gives its concurrence to the ECE Semiconductor Process and Manufacturing Technology certificate.

Best regards,
Tom Humanic

Thomas Humanic
Professor
Vice Chair for Undergraduate Studies
Department of Physics
The Ohio State University

From: Grassman, Tyler <grassman.5@osu.edu>
Sent: Wednesday, August 16, 2023 1:21 PM
To: Humanic, Thomas <humanic.1@osu.edu>
Cc: Kawakami, Roland K. <kawakami.15@osu.edu>
Subject: Concurrence request for new interdisciplinary semiconductor certificate (from Intel curriculum project)

Tom,

As part of one of the Intel-funded projects that OSU is involved in, an interdisciplinary committee of engineering and science departments (Roland has been a valued participant) has been working on developing some new certificates that students from various departments can take to better prepare them for the semiconductor manufacturing workforce. ECE has already established a few focused certificates; our committee has been concentrating on both expanding those to be more interdisciplinary (and generally more useful) and to creating new interdisciplinary ones altogether. The first of these latter I am attaching here, concerning Semiconductor Process and Manufacturing Technology. Because we are proposing to include a couple Physics courses within the electives list, we need concurrence from your curriculum committee as part of our submission to the college. We don't expect the student loan to be huge, and there are enough courses that they will be fairly spread out amongst the different departments. If anything, having courses included is almost more of a convenience to a given department's students since they can double-count two courses for their major.

Anyway, in order to submit this for approval review we need "letters of concurrence" from the departments' curriculum committees (although I'm told an email is fine); according to our provost the chair/POC for this role in Physics is you. Hopefully that is correct (if not, please forward to whomever is the correct individual). If you have any questions, comments, edits, … please let me know. Unfortunately we've got a bit of a short fuse

in order to get this submitted in time for the college committee to review it this semester, so the sooner we get this done the better (sorry for the rush).

Thanks,
Tyler Grassman

Tyler J. Grassman
Associate Professor
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Columbus, OH 43210

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Email: grassman.5@osu.edu
URL: https://engineering.osu.edu/people/grassman.5

STAT Approval

Grassman, Tyler

From: Lee, Yoonkyung
Sent: Friday, August 25, 2023 4:20 PM
To: Grassman, Tyler
Cc: Zhang, Yuan; Sivakoff, David; Kaizar, Elly
Subject: Re: Concurrence request for new interdisciplinary semiconductor certificate (from Intel curriculum project)

Dear Professor Grassman,

The Department of Statistics gives concurrence for the new undergraduate embedded certificate in Semiconductor Processing and Fabrication Technologies. For your information, in addition to STAT 3470 listed in engineering probability and statistics category in the proposal, we offer STAT 3450 and 3440 (currently offered only on the reginal campuses) for engineers, which are comparable to 3470. Some facts on these courses are noted for your consideration.

- We have capacity to enroll an extra 10-20 students per year in STAT 3470, particularly if they are allowed to enroll in the DH (Distance Enhanced) version where everything but the exams are online.
- STAT 3470 and 3440 are for 3 credit hours while 3450 is for 2 credit hours.
- The three courses differ in terms of special topics. STAT 3470 covers regression while 3450 does not, and 3450 covers multi-factor experiments instead. 3440 covers quality control.
- We typically offer in-person and DH versions of STAT 3470 and 3450, but not DL versions.

Feel free to reach out to us if you have any questions about these courses.

Best,
Yoon

Yoonkyung Lee, PhD
Professor of Statistics
Professor of Computer Science and Engineering (by courtesy)
College of Arts and Sciences Department of Statistics
440H Cockins Hall, 1958 Neil Ave, Columbus, OH 43210
614-292-9495 Office
lee.2272@osu.edu

October 31, 2023

To whom it may concern,

Intel is pleased to provide this letter of support for the creation of a new interdisciplinary academic certificate at The Ohio State University focused on *Semiconductor Processing and Manufacturing Technologies.* The rapid growth of the US microelectronics manufacturing industry is already creating domestic workforce pressures, while Intel's needs here in Ohio are particularly acute as we approach the operation of our new fabrication facility in New Albany. The Intel-funded Ohio Semiconductor Education and Research Program (SERP) was designed to help the educational institutions around Ohio ramp up and grow their ability to prepare students and trainees for careers in the semiconductor industry and serves as a keystone for Intel's entry into the Midwest. The creation of the academic certificate, along with others similar to it, including new certificates created by the ECE department and approved earlier this year, is an important piece of OSU's "Ohio Partnership for a Diverse and Inclusive Semiconductor Ecosystem and Workforce" SERP effort.

The *Semiconductor Processing and Manufacturing Technologies* certificate was developed to help prepare students within a wide range of STEM fields for careers at Intel and within the broader semiconductor industry, with a particular focus on the role of process engineer. With guidance from Intel's subject matter experts regarding desirable skills and knowledge for this critical role, the OSU team recognized the need for interdisciplinarity and broad academic accessibility. We believe that the resulting curriculum set forth in this certificate, along with the other ongoing efforts in OSU's SERP projects, will serve as an excellent tool to both attract students into this exciting field and give OSU's graduates the skills they need to flourish therein.

If you have further questions, do not hesitate to contact me at gabriela.cruz.thompson@intel.com.

Sincerely,

Gabriela Cruz Thompson
Senior Director, Intel University Research and Collaboration

Intel Corporation
2111 NE 25th Ave.
Hillsboro, OR 97124
www.intel.com