Michigan Association of State Universities
101 S. Washington Square, Ste. 600
Lansing, MI 48933

Academic Program Review
New Program or Major Revision

University of Michigan Ann Arbor
ECE Master’s of Engineering (MEng)

Institution
Fall 2020

Program Title
M Eng

Effective Term & Year
Degree

Program Review Status
☐ Submitted for review with Institutional Governing Body approval
☐ Submitted for review prior to Institutional Governing Body approval (est. approval date: ________________)
☐ Previously reviewed (Ref. #__________) – resubmitted with changes
☐ Previously reviewed (Ref. #__________) – resubmitted without changes
☒ Other: Approved by the College of Engineering faculty on 12/10/2019 _________________________________

Locations
☒ Main campus
☐ Existing outreach / extension sites
☐ Hybrid / online
☐ New locations: ______________________________________________________
☐ Principal clinical sites will be: _______________________________________

Resources
☒ Reallocation of existing resources
☐ New resources required
  ☐ Grant funding
  ☐ Other: ____________________________________________________________

Students
☐ New target population
☒ Current enrollment shift
☐ Local community demand
☐ Other: _____________________________________________________________
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### Submitting Authority

Susan M Collins  
Interim Provost and Executive Vice President for Academic Affairs  
University of Michigan - Ann Arbor  
4/24/2020

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For Submission to Michigan Association of State Universities (MASU)
New Program at College of Engineering, University of Michigan, Ann Arbor
Master of Engineering (MEng) in ECE

Program Director: Leung Tsang
Cognizant Faculty: Raj Nadakuditi, Jim Freudenberg

1. Summary

ECE proposes the launch of a Master of Engineering (MEng) degree program to serve students pursuing a terminal, professional master’s degree. This degree is offered in a specific concentration area. The proposal below outlines the general program requirement and policy, as well as the first two concentrations to be offered, in Data Science and Machine Learning (DS/ML) and Autonomous Systems (AS). A few more are in the pipeline under discussion, including semiconductor manufacturing, VLSI, embedded systems, and cybersecurity.

Compared to our existing ECE Master of Science (MS) program, the key features and differentiations of the proposed ECE MEng are as follows:

1. a more structured curriculum with less flexibility,
2. more emphasis on hands-on and practical training,
3. more emphasis on communications, project management, leadership and entrepreneurial training, and
4. a curriculum aligned with emerging application areas of high workforce demand rather than aligned with fundamental research areas.

With an emphasis and explicit requirement on communication skills and entrepreneurial training, the proposed MEng also leverages the strong course content of the Center for Entrepreneurship (CfE), part of our #1 nationally ranked entrepreneurship program here at UM.

2. Motivation, Rationale and background

ECE has had a fairly large MS program over the past 5-8 years. We receive between 1200 to 1400 applications a year to our MS program, admit around 550, and enroll on average between 170 to 210 students per year. Some of these (a small number) are originally applicants to our PhD program but admitted and enrolled at the MS level.

Our MS program is offered in 12 majors. The enrollments in these 12 majors are unevenly distributed. Below we list the 12 major areas with the 2019 applications put in parenthesis. The majors are: (i) Network, Communication, and Information Systems (NCIS) (83), (ii) Computer Vision (CV) (124), (iii) Control (85), (iv) Electromagnetics (48), (v) Embedded Systems (148), (vi) Integrated Circuits (VLSI) (199), (vii) MEMS (15), (viii) Optics (41), (ix) Power and Energy (76), (x) Robotics (121), (xi) Signal and Image Processing and Machine Learning (SIPML) (399), and (xii) Solid State and Nano (SS) (36) The majors are largely aligned with ECE internal research areas, with a near one-to-one correspondence, the only exception being (v) and (vi), both of which belong to our VLSI and Circuits area.

1 These roles (program director and cognizant faculty) and their responsibilities are described in Section 7.
2 To avoid confusion, a chosen field of interest/specialty is referred to as a "concentration" under the proposed MEng program; the same is referred to as a "major" under the existing MS program.
There are two distinct characteristics to our MS program. The first is that the way the majors are organized, as well as the courses we offer, are heavily driven by how we organize research; in other words, they are fundamentally structured for PhD-bound (or pre-candidate) students, rather than as direct response to workforce demand of MS graduates. The second is that our MS degree requirement has substantial flexibility built in. Of the 30 credits requirement, at least 24 are required to be technical graded courses, but only 9 need to be in the student’s chosen MS major (equivalent of 3 courses) and only 12 are required to be ECE courses at 500 level or higher. This essentially means that an MS student can graduate officially with major in XYZ while having taken no more than 3 graduate courses in XYZ.

There is good reason behind this flexibility: it serves well students who either are not quite sure what they are interested in by providing them with the ability to sample a variety of courses from different areas. It also serves well students who want to keep PhD an option further down the road. It, however, is not designed for students seeking professional training in the form of a terminal master’s degree. For one, the added flexibility not only does not benefit these students but can indeed hurt them by not providing a more prescriptive and structured curriculum framework. For another, most of our existing graduate courses do not provide enough hands-on training for these students embarking on practical engineering professions. As a result, our current program structure is not best positioned to take advantage of enormous interest and workforce demand in areas fundamental to ECE.

In short, our MS program is not meant for all our students, approximately 200 per year. Our conclusion is that our students are best served by two models, the existing MS program, and a new, Master of Engineering (MEng) program, designed for students seeking a terminal master’s degree and associated professional development, and featuring the following distinctions from our existing MS program as outlined earlier in the introduction: (1) a more structured curriculum with less flexibility, (2) more emphasis on hands-on and practical training, (3) more emphasis on communications, project management, leadership and entrepreneurial training, and (4) a curriculum aligned with emerging application areas of high workforce demand rather than aligned with fundamental research areas.

By creating an MEng track to better serve professional education needs, we will also work toward making our existing MS a (relatively) better funded, proper pipeline program for our PhD program, which we very much need.

It should be clear that the basic motivation behind creating this MEng degree program in ECE is to better serve our existing residential student pool, rather than as a way to increase our student pool. Our first and foremost objective is to divert a substantial subset away from our existing MS population to this new MEng program as a better option for them. However, we do realize the potentially significant interest from a completely different audience, those in the professional workforce seeking continuing education. If and when such interests and demand emerge, we are open to adapting course scheduling and delivery (in-class vs. online) options to meet such demand.

It is worth noting that such a professional degree also offers great potential for interaction with industry, as it responds to employment needs and offers education in rapidly emerging subject areas, in which companies may have difficulty ramping up their expertise and fulfilling workforce needs from more traditional degree programs.4

3. Meeting emerging professional demands

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3 Each MS major has a set of pre-approved courses that automatically count toward this “major” (9-credit) requirement; a second set of courses may count toward this requirement with approval from an academic advisor (each major is designated one).

4 Our experience with Ford through ISD and its programs is that this would be a great way for UM to have impact.
The concentrations areas in the MEng degree program are meant to meet emerging professional demands. We initially will focus on two such areas: (1) Data Science (DS) and Machine Learning (ML) and (2) Autonomous Systems. The rationale behind these two concentrations is as follows.

**The Data Science (DS) and Machine Learning (ML) Concentration**

Needless to say there has been a huge rise in demand for data science and machine learning training from our students and their potential employers. In 2019, a combined total of 38% (1375) of our MS applicants chose the two majors of Signal and Image Processing and Machine Learning (SIPML) and Computer Vision (CV). Our goal in creating the ECE MEng DS/ML concentration is to train, first and foremost, electrical and computer engineers equipped with data science tools to take on modern engineering projects. Specifically, the curriculum will have a clear and distinct focus on the use of data in engineering systems, by emphasizing (1) physics based models and dealing with underlying uncertainty in practice, (2) the entire design cycle involving data in an engineering problem, including data acquisition, curation, storage, pre-processing, feature engineering, rendering and display, and (3) interpreting the result in the same engineering context and understanding its impact on subsequent decision making.

In other words, we place an emphasis on the understanding of the engineering problem, the ability to conceptualize how data could be useful in such a context, the ability to obtain such data and the pre- and post-processing required to make data useful, and the ability to use the resulting analytics to inform decision making for the same engineering problem. Such an emphasis makes this MEng concentration an integral part of ECE: it is built upon many technical concepts fundamental to ECE, such as data acquisition (sensors, sensing and instrumentation), signal processing, and information and decision sciences.

This design philosophy is closely aligned with what we often hear from industry. In a recent conversation with researchers and engineers from Ford, they observed that it is very easy for them to hire someone trained in automotive engineering or data science, but much harder to find someone trained in both, and near impossible to find someone versed in automotive engineering, data science, and data engineering, which is what they really want. We've heard similar comments from other employers. This ECE MEng in DS/ML will be able to fill this gap.

**Related Program in Data Science and Official statements concerning the Data Science Master’s Program at UM**

A related program is the MS Degree in Data Science, that is jointly offered by CSE, SI, Stats and Biostatistics. To distinguish the two, the following statements have been agreed to by ECE and the Data Science Master’s Program and will be used and posted.

**Master of Science Degree in Data Science, joint between CSE, SI, Stats and Biostatistics**

“The MS DS program aims to train well-rounded data scientists who have the skills to work with a variety of problems involving large-scale data common in the modern world. The focus of the curriculum is computational tools and statistical analysis as well as hands-on experience.”

**(Proposed) Master of Engineering degree in Electrical and Computer Engineering with concentration in Data Science and Machine Learning**

“The ECE MEng DS/ML concentration aims to train electrical, computer, and systems engineers so that they are equipped with the theory and practice of data science and machine learning to work on modern engineering systems for sensing, control, inference, planning and decision making. The curriculum emphasizes rigorous theory, hands-on practice and developing skills for computational reasoning about large-scale complex engineered systems.”

**The Autonomous Systems Concentration**

The second ECE MEng concentration is Autonomous Systems. For the two majors of Control and Robotics, there were a total of 206 MS applicants in 2019, 15% of the 1375 total. Although there is an MS in Robotics in the CoE, our MEng concentration in Autonomous Systems will have an emphasis on the broader family of autonomous systems, which requires knowledge in sensors/sensing, signal processing, and control, all areas fundamental to
ECE. This concentration is thus designed to produce engineers versed in the various design and engineering aspects of autonomous systems and operations.

As we officially start the MEng program, we anticipate that more concentrations will be added, including semiconductor manufacturing, VLSI, and embedded systems and cybersecurity.

4. Other similar ECE MEng programs in the US and how we compare

Of electrical engineering programs at our peer universities, the Georgia Institute of Technology and Purdue both offer professional Master’s degrees (residential as well as online). UC Berkeley has a relatively new MEng program (started within the last two years). Our proposed MEng program is closest to the Berkeley program in curriculum structure. Below we give more detail on the Purdue and the Berkeley programs, respectively.

The Purdue Professional Master’s Program (PMP) offered by ECE, in the concentration of ECE Technology Innovation5: This is a 30-credit, residential program designed for one-calendar year completion time. This program purports to develop leaders in technology innovation. Of the 30 credits:
- 12-15 credits are technical depth courses,
- 6-9 are technical breadth courses (at least 6 of these are through a sequence of 1-credit short courses),
- 9 in professional development (obtained through the MS Ideas to Innovation course, which links a yearlong project to professional skills development seminars).

The program requires depth in one of four ECE technical areas:
1) Fields and Optics (FO),
2) Micro and Nanotechnologies (MN),
3) VLSI and Circuit Design (VC), and

Students acquire breadth through a set of 1-credit courses developed specifically for this concentration. Students also participate in a yearlong science-to-systems design project that also includes professional skills development activities.

The UC Berkeley MEng in EECS6: This is a 25-credit program, which can be completed in one academic year (two semesters of Fall and Spring). The objectives are to give students a deeper technical specialization through courses and a practical experience through projects and to train students in leadership skills. Of the 25 credits:
- 12 credits are from technical courses,
- 5 credits from Capstone projects, and
- 8 credits on leadership, which includes 2 in communications and 6 in R&D technology management and ethics, entrepreneurship, accounting & finance, marketing and product management, technology strategy, industry analysis etc.

The Berkeley EECS MEng degree involves two institutes:
- The Engineering School covers the technical courses;
- The FUNG Institute covers the Capstone projects and the leadership courses. The Capstone projects can be Faculty projects or Partnership projects. The Partnership projects can be from industries, National Laboratory or academic institutions.

There are five areas of concentration:
1) Data science and systems,
2) Physical electronics and integrated circuits,
3) Robotics and embedded software,
4) Signal processing and communications, and
5) Visual computing and computer graphics.

How we compare to these programs and our unique features: As mentioned earlier, the proposed ECE MEng program is closest in design and structure to the Berkeley EECS MEng program. Setting aside technical

5 https://engineering.purdue.edu/ECE/Academics/PMP
6 https://funginstitute.berkeley.edu/programs-centers/full-time-program/engineering-departments/eecs/
requirements, which are similar, the key difference lies in the fact that the Berkeley model is a joint program between Engineering and their FUNG Institute, and focuses more heavily in leadership and management training, whereas as mentioned earlier, the proposed ECE MEng leverages the strong course content of the Center for Entrepreneurship (CfE), with a heavy focus on communication skills and entrepreneurial training. Herein also lies a unique feature and strength of this program, which is to leverage our #1 nationally ranked entrepreneurship program and the CfE here in the College of Engineering.

5. Similar Programs in the State of Michigan

Within College of Engineering of University of Michigan at Ann Arbor the Civil and Environmental Engineering Department (CEE) at offers MEng in 3 programs: (a) MEng in Construction Engineering and Management (CE&M), (b) MEng in Structural Engineering (c) MEng in Smart Infrastructure Finance (InfraTech). All three programs are two-semester, 26-credit program for students who want to pursue professional careers in industries. We are not aware of similar MEng programs elsewhere in the state of Michigan.

6. Curriculum Design

Program overview: The ECE MEng degree program will be a 26-credit program with the following components:

1. At least 12 credits in technical courses, of which at least 9 from a set of core courses for a selected MEng concentration; the rest from a set of approved non-core courses.
2. At least 4 credits in project and design courses in the same concentration.
3. At least 4 and up to 6 credits in ENTR courses; these are in the areas of entrepreneurship, leadership, communication and project management. This requirement may be waived by the MEng program director or the cognizant faculty, in cases such as continuing education and other warranted circumstances.
4. An optional summer internship, which can count up to 6 credits, corresponding to a 12-week full-time internship.

Example combinations of these toward program requirement include:

(i) 18 technical (12 in core, 6 in non-core), 4 in project, 4 in ENTR
(ii) 18 technical (9 in core, 9 in non-core), 4 in project, 4 in ENTR
(iii) 15 technical (9 in core, 6 in non-core), 8 in project, 4 in ENTR
(iv) 12 technical (9 in core, 3 in non-core), 8 in project, 6 in ENTR
(v) 12 technical (9 in core, 3 in non-core), 4 in project, 4 ENTR, and 6 in internship
(vi) 12 technical (all in core), 4 in project, 4 ENTR, and 6 in internship

We elaborate on each of the program components below.

Core requirement (at least 13 and up to 22 credits total): the core requirement consists of the core courses in the selected concentration and the design/project courses in the same concentration. These courses will deliver the technical/engineering foundations for the student, with a significant emphasis on hands-on and project experience, all in the concentration area.

Non-core/Electives (up to 9 credits total): these constitute the flexible component of the program. Approved non-core courses include any "M" course in the ECE Graduate Manual – these are courses that count toward fulfilling a major requirement in one of our existing MS major areas, provided they are not simultaneously listed as a core/lab requirement for a concentration. A course not listed as "M" by the ECE Graduate Manual may count as an accepted non-core course with pre-approval from the MEng program director.
Communications and e-ship skills: these have become an increasingly important part of any professional training program and reflect our belief that communications, innovation, leadership and management skills are complementary and even critical to a student's technical training.

Internships: Practical training is recognized as a potentially very critical and beneficial part of a professional degree program and is thus accepted as an option. It is not required, as we do not guarantee such opportunities for all students, particularly international students. To qualify for credit, a report from the student summarizing the internship along with proper documentation from the employer need to be submitted. An international student is also required to return for the fall term following the summer internship to obtain this credit.

An MEng student will not receive credit for courses outside the above requirement without pre-approval from the program director.

Boundary cases: what is the maximum or minimum core technical training a student can leave with?

At one end of the extreme, a student can opt to take a total of 22 credits toward their core technical requirement and can in principle take all of them in the major area. This could include possibly 14 credits in technical courses and 8 in design/projects. The student completes the degree requirement with 4 credits in communications.

At the other end of the extreme, a student can opt to take a total of 13 credits toward their core requirement (9 in technical courses and 4 in design/projects). The student completes the degree requirement with at least 3 (thus a total of 16 credits in technical courses) and up to 9 (for a total of 21 credits in technical courses) credits in a minor area and a combination of communications courses and internship.

Why 26 credits: Professional education degrees offered by peer institutions (see examples given earlier) are typically designed for completion within a calendar year and sometimes two semesters. To remain competitive and aligned with this broader context, the proposed 26-credit degree requirement is meant to be attainable within one calendar year, and, if pursued more aggressively, within two semesters (Fall followed by Winter). A second reason lies in the fact that the proposed curriculum structure confers the same or higher level of technical training in a specialization as elaborated below.

To be specific, the core technical requirement under the proposed MEng program is on par with or stronger than that under the current MS program:
- a minimum of 13 credits at the 500-level (9 in core technical and 4 in lab/design) vs. a minimum of 12 credits at the 500-level;
- a minimum of 13 credits in core technical courses vs. a minimum of 9 credits in core technical courses.

Its breadth requirement is weaker compared to the current MS program:
- no requirement (but room for up to 9 additional core or elective technical credits) vs. a required additional 12 credits in technical graded courses.

It is, however, worth noting that since most our prospective students are international, who may not be able to take advantage of the summer intern option if they wish to complete the degree in two semesters, they may be more likely to fulfill the degree requirement by taking additional technical courses, effectively narrowing this difference.

Therefore, even though the total credit requirement of 26 is less than the standard 30 for an MS degree, the technical training within the proposed MEng degree has only strengthened. We believe this is well aligned with workforce demand: breadth requirement is less critical for someone seeking a terminal, professional degree. This is particularly true for a professional seeking continuing education in a focused area.

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7 The 30-credit Purdue degree is advertised as a one-year program but appears less technically intensive. The degree requirement includes a minimum of 6 (and up to 9) 1-credit breadth courses, which may be technically less demanding and can be added on top of 12 credits of technical courses. The requirement also includes a 9-credit professional development component spanning the year (presumably with project and links to professional development skills). This may indeed require a student to say over the summer term.
7. Specific program requirements, policies, and continued development

The following set of ENTR courses are expected to be common to all concentrations, along with the semester in which they are offered and the number of credits they carry.

**Communications and e-ship (4-6 credits):**
- ENTR 407 (Entrepreneurship Hour, F/W/1)
- ENTR 408 (Patent law, F/W/1)
- ENTR 520 (Tech-inspired business models, F/W/3)
- ENTR 530 (Innovation & IP strategy, F/W/3)
- ENTR 550 (Interpersonal skills, F/W/3)
- ENTR 560 (Project mgmt & consulting, F/W/3)
- EECS 406 (High-tech entrepreneurship, F/W/4)

The program specifications below list existing courses. As the list includes courses in DS, ML and Computer Vision (CV), some of the fastest growing areas in ECE, we anticipate continued curriculum evolution and development in these areas outside the MEng program. As newer versions replace older versions and more courses are added, we expect to update the specific accepted course lists for the MEng program accordingly.

In addition, relevant EECS 598 (Special Topics) courses may be allowed to satisfy any of the requirements per program director’s approval.

7.1 Data Science and Machine Learning Concentration (DS/ML)

For the DS/ML concentration, the list of accepted courses in each category is as follows.

**Core requirement (>=9 credits):**
- EECS 501 (Probability and Random Processes, F/W/4)
- EECS 504 (Foundations of CV, F/W/3)
- EECS 505 (Computational DS and ML, F/W/4): this course can count toward either major or design requirement, but not both.
- EECS 542 (Vision Processing, F/W/3)
- EECS 545 (Machine Learning, F/W/3)
- EECS 551 (Math Methods for SP, F/4)
- EECS 556 (Image Processing, W/3)
- EECS 564 (Estimation, Filtering, and Detection, W/3)
- EECS 568 (Mobile Robotics, W/4)

**Accepted non-core courses:** An "M" course in the ECE Graduate Manual – these are courses that count toward fulfilling a major requirement in one of our existing MS major areas. A course not listed as "M" by the ECE Graduate Manual may count as an accepted non-core course with pre-approval from the MEng program director.

**Project/Design/Lab requirement (>=4 credits):**
- Python for Everybody Specialization (5-course sequence on Coursera, taught by C. Severance at SI, F/W/SS/2)
- EECS 505 (Computational DS and ML, F/W/4): this course can count toward either major or design requirement, but not both.

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8 In a recent meeting with KLA on their continuing education needs for their employees, they provided a list of courses they are interested in having their engineers take. There is a near-100% overlap between their list at the 500-level and this list of major requirement for the MEng degree program, which has been independently developed by ECE. This serves as a separate, market validation for our curriculum design.
- EECS 605 (Design in DS and ML, F/W/4): this is a required course for the DS/ML concentration.

Examples of course choices and pathways to completion are as follows (numbers in parenthesis denote credit hour counts):

Example 1: all courses, no intern; 4-credit ENTR; 23-credit core
- Fall: 501 (4), 545 (3), 505 (4), ENTR 407 (1) – 12 total
- Winter: 542 (3), 556 (3), 605 with Python (6), ENTR 550 (3) – 15 total

Example 2: all courses, no intern; 4-credit ENTR; 16-credit core; 7-credit minor
- Fall: 545 (3), 505 (4), a 1st course in VLSI (3), ENTR 550 (3) – 13 total
- Winter: 542 (3), 605 with Python (6), a 2nd course in VLSI (4), ENTR 407 (1) – 14 total

Example 3: mix; 4-credit ENTR; 16-credit core; 6-credit intern
- Fall: 545 (3), 505 (4), ENTR 407 (1) – 8 total
- Winter: 542 (3), 605 with Python (6), ENTR 550 (3) – 12 total
- SS: qualified internship (6)

Example 4 mix (for international students); 4-credit ENTR; >=16-credit core; 6-credit intern
- Fall: 545 (3), 505 (4), ENTR 407 (1) – 8 total
- Winter: 542 (3), 605 with Python (6) – 9 total
- SS: qualified internship (6)
- Fall: another ECE course (3), ENTR 550 (3) – 6 total

7.2 Autonomous Systems (AS)

For the AS concentration, the list of accepted courses in each category is as follows.

Core requirement (>=9 credits):
- EECS 460 (Control Sys Analysis & Design, F/W/4)
- EECS 501 (Probability & Random Processes, F/W/4)
- EECS 504 (Foundations of CV, F/W/3)
- EECS 505 (Computational DS & ML, F/W/4)
- EECS 542 (Vision Processing, F/W/3)
- EECS 551 (Mathematical Methods for SP, F/4)
- EECS 556 (Image Processing, W/3)
- EECS 560 (Linear Systems Theory, F/W/4)
- EECS 567 (Intro to Robotics, F/3)
- EECS 561 (Design of Digital Control Systems, W/3)
- EECS 562 (Nonlinear Sys Control, W/3)
- EECS 563 (Hybrid Control, F/3)
- EECS 564 (Estimation, Filtering, and Detection, W/3)
- EECS 565 (Linear Feedback Control Systems, W/3)

Accepted non-core courses: An “M” course in the ECE Graduate Manual – these are courses that count toward fulfilling a major requirement in one of our existing MS major areas. A course not listed as “M” by the ECE Graduate Manual may count as an accepted non-core course with pre-approval from the MEng program director.

Project/Design/Lab requirement (>=4 credits):
- EECS 461 (Embedded Control Systems, F/W/4)
- EECS 452 (DSP Design Lab, F/W/4)
- EECS 464 (Hands-on Robotics, W/4)

Examples of course choices and pathways to completion are as follows:
Example 1: all courses, no intern; 4-credit ENTR; 22-credit core
- Fall: 560 (4), 542 (3), 505 (4), ENTR 407(1) – 12 total
- Winter: 565 (or 562/563) (3), two of (461, 452, 464) (8), ENTR 550 (3) – 14 total

Example 2: all courses, no intern; 4-credit ENTR; 23-credit core
- Fall: 501 (4), 460 (4), 505 (4), ENTR 407 (1) – 13 total
- Winter: 556 or 564 (3), two of (461, 452, 464) (8), ENTR 550 (3) – 14 total

Example 3: mix; 4-credit ENTR; >=15-credit core; 6-credit intern
- Fall: 560 (4), 505 (4), ENTR 407 (1) – 9 total
- Winter: 565 (3), one of (461, 452, 464) (4), ENTR 550 (3) – 10 total
- SS: qualified internship (6)
- Fall: another ECE course (3-4)

8. New courses

The new MEng program put more emphasis on hands-on and practical training. At least 4 credits in project and design courses are required. In supporting this MEng program, new courses are being developed for the purposing of adding hands-on and practical training components to our existing curriculum. Presently, a new course, EECS 605 Data Science and Machine Learning Design Laboratory has been approved. This course uses a sequence of hands-on projects to bring into sharper focus the following concepts in the data-to-decision cycle: 1. how smart (or bad) data can positively (or negatively) affect decisions in the design and operation of an engineering system; 2. how to acquire such data, clean and store it via appropriate pre-processing and post-processing it for aiding reproducibility; 3. how to display, render, deploy and interpret it in the context of a real or simulated closed-loop type cloud based engineering system; and finally, 4. how to communicate the shortcomings and vulnerabilities of such systems, including plug-and-play systems using pre-trained off-the-shelf deep learning models, when integrated into a decision-making system. 5. conceptualization and execution of an open-ended, reproducible cloud-based design project. A similar hands-on course on sensing/sensors and instrumentation will be development over the next year for the autonomous systems concentration.

9. Program administration

The program will be administered by ECE, as it does the current ECE MS program. As in the case of our MS program supervised by an MS Chair, there is a designated MEng program director or the MEng Chair; each concentration area has a cognizant faculty. The MEng Chair together with the cognizant faculty will supervise the academic side of the program. ECE will provide programmatic and staff support as we do for the MS program, including academic advising, career counseling and community building.

ECE has an established process for making changes to curriculum and academic programs within ECE. For the proposed MEng, this means that we have an established process for (1) defining and approving new MEng concentrations within ECE, and (2) removing a concentrating or the entire program should circumstances warrant it. This process includes proposals/requests from faculty, followed by discussions and vote by the ECE Graduate Academics Committee led by the Associate Chair for Graduate Affairs, and followed by discussions and vote at ECE faculty meetings. The Graduate Academic Committee will then submit CARFs or other required documents to the College Curriculum Committee.

We also have an established process to handle degree requirement petitions by students, which go through academic advisors, followed by discussion and decision by the ECE Graduate Academics Committee.
Finally, we will periodically assess the current MEng concentrations by conducting the following:
- track admissions and selectivity data for different areas;
- monitor students’ GPA, courses taken and time to graduate;
- examine course evaluation data;
- monitor students’ job placement;
- examine student exit surveys to assess student experience with the program;
- in conjunction with C&E to assess the performance of MEng students in their courses as well as suggest potential new C&E courses considered beneficial;
- benchmark against similar programs at other schools, including those mentioned earlier;
- engage with our industry partners and the ECE Council to assess the continued industry relevance of the concentrations and their course requirements.
A synopsis of the internal MEng assessment will be provided to the CoE Associate Dean for Graduate Education’s office each year.

10. Program Costs, Faculty and staff resources

In supporting this MEng program, new courses are being developed for the purpose of adding hands-on and practical training components to our existing curriculum. The program requirement proposed above for the DS/ML concentration adds exactly one new course (EECS 605); a second new course, EECS 505 was recently added (piloted as EECS 598 in F18 and W19, officially offered as EECS 505 in F19). We are confident that ECE will be able to staff the development and teaching of these new courses in the long run. As mentioned earlier in the introduction, we do not anticipate an increase in the overall size of enrollment at the Master’s level (between MS and MEng) in the foreseeable future, and therefore do not expect additional staffing needs for other regular EECS courses listed in the proposal.

There will be no change in tuition rate. The tuition rate will be the same as the current MS program.

New resources are not needed for this program. Our first objective is to divert a substantial subset away from our existing MS population to this new MEng program as a better option for them. Hands-on curriculum components are being developed to serve this program; these do not require new resources. Staff support for the new program will also be provided by existing human resources.

The main program costs consist of (1) faculty (and graduate student instructor) time in developing and teaching the new course(s), and (2) staff time in maintaining a separate auditing system managing students in the new program. Cost under (1) is readily absorbed by the ECE operating budget; cost under (2) is relatively minor as there will be no net increase to the total number of Master’s students in ECE and will similarly be absorbed by the ECE operating budget.

11. Available and/or needed equipment

This new program does not require additional or new equipment that we are not already using in existing instructional activities. Software and hardware needs include access to standard/off-the-shelf software packages such as MATLAB and Python, access to computing clusters, availability of devices including commercially available RGBD camera, ultrasonic sensors, and LiDAR. ECE can meet all these software and equipment needs.

12. Faculty qualifications
   a. The faculty who will be teaching classes in the data science and machine learning program are from two research areas
i. Signal & Image Processing and Machine Learning Faculty, https://ece.engin.umich.edu/people/directory/researchers-by-area/signal-image-processing-and-machine-learning and

ii. The computer vision faculty, https://ece.engin.umich.edu/people/directory/researchers-by-area/computer-vision/

b. The faculty who will be teaching classes in the and Autonomous Systems (AS) program is from two research areas

i. The Control Systems faculty, https://ece.engin.umich.edu/people/directory/researchers-by-area/control-systems/ and

ii. Robotics and autonomous system faculty
https://ece.engin.umich.edu/people/directory/researchers-by-area/robotics-autonomous-systems/

13. Enrollment, scheduling plans, and implementation

We plan to enroll the first batch of MEng students in the DS/ML concentration in Fall 2020. We hope to obtain approval from the CoE by the end of Fall 2019, and the State of Michigan approval by June/July of 2020. With this timeline in mind, we expect to conduct regular MS admissions during the AY19-20. If/When the State approval comes through in the summer of 2020, we plan to give a subset of admitted and matriculated MS students the option of switching from their admitted MS program to this new MEng program. In subsequent years there will be a separate MEng admissions process. The projected enrollment of the MEng DS/ML concentration is between 25-50 for the first cohort in AY20-21; the projected enrollment of the MEng AS concentration is around 20-30 for the first cohort in AY21-22.

MEng Admissions: We expect an identical process to the current MS admissions. The admissions criteria will be equivalent. The key differentiator lies in whether a student intends to pursue a terminal/professional master’s degree vs. keeping open the idea of pursuing a PhD.

Pathways to MS/PhD: There isn’t an explicit pathway toward an MS or PhD degree in ECE for obvious reasons. As stated above, for our own students or applicants, the advice should be that if they want to keep options open or are unsure what they’d like to do then they should take the MS/PhD route and not MEng. An MEng student interested in pursuing an MS (resp. PhD) degree mid-way through the program or upon completion of the MEng can apply to our MS (resp. PhD) programs just like anyone else and go through the standard admissions process for the latter. Such a student can count up to 12 credits of technical courses (including lab/design) toward the MS (resp. PhD) degree, subject to the ECE MS/PhD program requirement and Rackham’s residency/candidacy policies.

14. Library and other learning resources

ECE is currently working with Nexus to create an online version of EECS 505 (listed above as part of the design/project requirement for the DS/ML concentration). If and when that is completed, student may be allowed to take either version.

15. Specialized facilities, including external sites as required

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9 The subset refers to those admitted and matriculated in the SIPML area of our MS program, as these students will be the closest aligned in terms of interest and technical background, as well as meeting admissions standards of the proposed MEng degree in DS/ML.
No specialized facilities or external sites are required. However, students can optionally conduct a summer internship in industry, which can count to 6 credits, corresponding to a 12-week full-time internship.

16. Pathways to degree completion

We envision the possibility of completing the ECE MEng degree requirement through a sequence of stackable credentials. In particular, as part of this proposal we would like to offer two-course certificates, which can be either credit or non-credit based. A certificate is conferred upon the successful completion (by the credit and non-credit criteria, respectively) of a set of two courses in the major and lab/design categories listed above. These certificates can subsequently be converted to credit at the time of enrolling in the MEng program.

We also envision the possibility of including the proposed MEng in the existing SUGS framework, i.e., the proposed MEng program can be completed by our own undergraduate students via a process similar to the existing SUGS, with identical double counting rules (8 credits) applied. By extension, we also envision allowing a JI-SUGS pathway towards the MEng degree. The only decision remaining to be made is the GPA threshold, which is currently set at 3.6 for existing SUGS leading to the completion of our MS degree. This will be discussed by the ECE Graduate Academics Committee and approved by the ECE faculty at a later date.

17. Accreditation Requirement

There are no accreditation requirements.