

Modify Approved Graduate Academic Program

The Graduate Council approves all major curriculum changes, deletions and additions to graduate certificate, graduate degree and doctoral degree programs. Proposals and other actions pertaining to policies and procedures governing graduate education must be approved by the Council and then submitted to the Provost, Senate and Board, as applicable, for approval.

Academic units, modifying the curriculum of an existing graduate program or renaming, merging or splitting a program must submit a proposal to Graduate Council for review and approval. Major program modifications include course deletions or additions that change the nature of the program, or distribution of courses in the program, or change of total credit hours required.

Please complete this brief proposal and submit an electronic copy to **Claire Rammel@oakland.edu**.

- merge programs split program rename program modify program

Effective Term/Year	Fall 2017
Name of Current Program(s)	Systems Engineering M.S.
Name of Proposed Program(s)	N/A
Departments	Industrial and Systems Engineering (ISE) Electrical and Computer Engineering (ECE)
College/School	SECS

I certify that the above proposal has been reviewed and approved by the appropriate Department and College/School committees:

Robert Van Til Daniel Alois 1/8/2017 Robert Van Til Daniel Alois
 Dept Chair or Director (signature) Date Dept Chair or Director (print)

Louay Chamra 1/23/2017 Louay Chamra
 Dean of College/School (signature) Date Dean of College/School (print)

Approved Claudia Petrusca 3/15/2017
 DECISION OF GRADUATE COUNCIL Date

3/2007

Approved Graduate Council
 Modify Existing Graduate Program

List proposed program changes related to merging, splitting, renaming or modifying a program.

1.1 Current academic program(s): Systems Engineering M.S.

1.2 Proposed modification to current program (brief description)

The administration of the program will be transferred from the Electrical and Computer Engineering department to the Industrial and Systems Engineering Department. The current list of course requirements will be removed due to duplication with existing course requirements in the Mechatronics M.S. program and Electrical and Computer Engineering M.S. program. A new list of course requirements will be added to the program using existing courses and will have a systems integration focus. No new courses will be added and no existing courses will be deleted.

2. Describe the reason(s) for the proposed change.

Rationale for removal of current course requirements:

The existing course requirements that are listed under 3 options in the Systems Engineering M.S. program duplicate course requirements offered by the ECE Dept. in the Mechatronics M.S. program and/or the Electrical and Computer Engineering M.S. program. Students currently enrolled in any of these 3 options in the Systems Engineering M.S. program will be allowed to finish their degree program since the ECE Dept. will not be cancelling any courses needed by students in the existing Systems Engineering M.S. program.

Rationale for new course requirements:

The International Council on Systems Engineering (INCOSE) defines Systems Engineering as follows:

“Systems Engineering is an interdisciplinary approach and means to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, then proceeding with design synthesis and system validation while considering the complete problem: operations; performance; test; manufacturing; cost and schedule; training and support; disposal. Systems Engineering integrates all the disciplines and specialty groups into a team effort forming a structured development process that proceeds from concept to production to operation.”

The proposed new course requirements for the Systems Engineering M.S. will educate Systems Engineers who will serve as the primary interface between management, customers, suppliers, and specialty engineers in the systems development process. Note that where other engineering disciplines concentrate on the specifics of a system (electronics, mechanics, ergonomics, aerodynamics, software, etc.), Systems Engineers focus on the integration of all of these aspects as a coherent and effective system. Systems Engineers bring a particular perspective to the engineering process (such as requirements definition, top-level functional designs, project management, life cycle cost analysis, product lifecycle management) that serves to organize and coordinate other engineering activities.

ISE Dept. faculty have been working with BAE Systems, GM, FCA and Siemens as well as the ISE Department's Industrial Advisory Board to determine if there is a local market for such a Systems Engineering M.S. program, and the response has been very positive. In fact, BAE Systems is so interested in hiring such Systems Engineers with an M.S. degree that they have recently posted openings for internships and full-time positions on the OU Career Services website (stating that they will consider ISE M.S. students and graduates who have taken several Systems Engineering electives, but their preference would be for graduates with a Systems Engineering M.S. degree).

It is important to note that Systems Engineering is not the same field as Industrial and Systems Engineering, even though both contain "Systems" in their titles. Systems Engineering has its focus on product design (the roots are from the space program in the 1960's with the design of the Apollo spacecraft and Saturn moon rocket). Industrial and Systems Engineering is a much older field with its roots in the design of manufacturing systems, later branching out into other areas such as logistics systems, healthcare systems, service systems, etc. (i.e., they do not focus on product design).

Some of the basic tools of Systems Engineers are also used by Industrial and Systems Engineers. This allows the use of some courses to serve as core courses in the SE M.S. program and as elective courses in the ISE M.S. program, while a few also overlap as core courses in both programs. However, with its emphasis on product design, it is believed that many Systems Engineering M.S. students will take their general elective courses from outside the ISE dept. (primarily in Electrical and Computer Engineering or in Mechanical Engineering).

Based on our survey of local companies, there is a sustainable market for Systems Engineer M.S. graduates in southeast Michigan, especially among the defense companies (a traditional domain of Systems Engineers) as well as among the automotive OEM's and automotive tier 1 suppliers (especially due to their increased efforts concerning the design and development of autonomous/connected vehicles). There are currently 31 Systems Engineering M.S. programs in the U.S., OU's program is the only one offered in Michigan.

3. Current program(s) requirements. (admission requirements, program requirements, course offerings, delivery method and advising structure).

Current course requirements are listed under 3 options as follows.

1. Dynamic Systems and Control Engineering Option (32 credits)

Theory courses (4 to 8)

- APM 541 - Mathematical Analysis for Engineers I (4)
- APM 542 - Mathematical Analysis for Engineers II (4)
- APM 553 - Advanced Ordinary Differential Equations (4)
- MTH 555 - Complex Analysis (4 credits)
- SYS 520 - Signal and Linear Systems Analysis (4)
- ECE 533 - Random Signals and Processes (4)

Required courses (12 to 16) - Students are required to select at least three courses from:

- SYS 520 - Signal and Linear Systems Analysis (4)
- SYS 630 - Optimal Control Theory (4)
- SYS 631 - Estimation and Control Theory (4)
- SYS 674 - Digital Control Systems (4)

Depth areas (8 to 16) - A student is required to take at least two courses from one of the following depth areas. Students may take more than one depth area. (Depth area courses are listed at the end of this section.)

- Advanced Control Systems
- Robotic Systems
- Intelligent Systems
- Dynamic Systems
- Nonlinear Systems
- Microprocessor Control Systems
- Optimization of Systems

Electives (0 to 8) - Additional credits may be taken from the following electives:

- SYS: Any course with level 500 and above
- CSE 512, 513, 545, 552, 576
- ECE 525, 533, 567, 570, 572, 585, 625, 537, 638, 683
- ME 521, 569, 572, 574
- PHY 562
- With approval:
 - SYS 594, 595, 690, 691, 795

Thesis option (8 credits)

- SYS 691 - Master's Thesis Research (2 to 8)

2. Robotics Systems Engineering Option (32)

Theory courses (4 to 8)

- APM 541 - Mathematical Analysis for Engineers I (4)
- APM 542 - Mathematical Analysis for Engineers II (4)
- APM 553 - Advanced Ordinary Differential Equations (4)
- APM 565 - Differential Geometry (4)
- SYS 510 - Systems Optimization and Design (4)
- SYS 520 - Signal and Linear Systems Analysis (4)

Required courses (12 to 16) - Students are required to select at least three courses from:

- SYS 520 - Signal and Linear Systems Analysis (4)
- SYS 575 - Automotive Mechatronics I (4)
- SYS 623 - Dynamics and Control of Robot Manipulators (4)
- SYS 632 - Analysis of Nonlinear Control Systems (4)
- ECE 523 - Robotic Systems and Control (4)

Depth areas (8 to 16) - A student is required to take at least two courses from one of the following depth areas (Depth area courses are listed at the end of this section):

- Computer Systems
- Dynamic Systems
- Intelligent Systems
- Linear Control Systems
- Microprocessor Control Systems
- Nonlinear Systems
- Optimization of Systems

Electives (0 to 8) - Additional credits may be taken from the following electives:

- SYS: Any course with level 500 and above
- CSE 512, 513, 545, 552

- ECE 527, 533, 567, 570, 572, 585, 625, 537, 638, 683
- ME 521, 569, 572, 574
- PHY 562
- With approval:
- SYS 594, 595, 690, 691, 795

Thesis option (8)

- SYS 691 - Master's Thesis Research (2 to 8)

3. Systems Modeling and Computer Simulation Option (32)

Theory courses (4 to 8)

- APM 541 - Mathematical Analysis for Engineers I (4)
- APM 542 - Mathematical Analysis for Engineers II (4)
- APM 553 - Advanced Ordinary Differential Equations (4)
- APM 565 - Differential Geometry (4)
- SYS 510 - Systems Optimization and Design (4)
- SYS 517 - Probability and Its Engineering Applications (4)
- or
- ISE 517 - Statistical Methods in Engineering (4)
- SYS 520 - Signal and Linear Systems Analysis (4)

Required courses (12 to 16) - Students are required to select at least three courses from the following. Other electives that are appropriate to the student's Plan of Study require prior approval of the faculty adviser and department chair.

- SYS 520 - Signal and Linear Systems Analysis (4)
- SYS 563 - Foundation of Computer-Aided Design (4)
- SYS 569 - Computer Simulation in Engineering (4)
- or
- ISE 569 - Computer Simulation of Discrete Event Systems (4)
- ISE 587 - Foundations of Systems Engineering I (4)

Depth areas (8 to 16) - A student is required to take at least two courses from one of the following depth areas. (Depth area courses are listed at the end of this section.)

- Dynamic Systems
- Mechanical Systems
- Microprocessor Control Systems
- Nonlinear Systems
- Optimization of Systems

Electives (0 to 8) - Additional credits may be taken from the following electives:

- ISE: Any course with level 500 and above
- SYS: Any course with level 500 and above
- CSE 513, 545, 552
- ECE 527, 533, 567, 570, 572, 585, 625, 537, 638, 683
- ME 521, 569, 572, 574
- PHY 562
- With approval:
- SYS 594, 595, 690, 691, 795

Thesis option (8)

- SYS 691 - Master's Thesis Research (2 to 8)

4. Proposed change to the program. (admission requirements, program requirements, course offerings, delivery method and advising structure).

The 3 options with their course requirements listed in Section 3 above will be removed from the program. The courses will continue to be offered and will count towards other degrees offered by the ECE department. Currently, each option duplicates an option that is currently available in either the Mechatronics M.S. program and/or the Electrical and Computer Engineering M.S. program.

Whereas the students will be encouraged to take statistics courses, there will be no required mathematics courses. This is in line with the ISE department's other master's program requirements. The Foundations of Systems Engineering – I course is the only required core course. This course covers customer needs assessment for engineering system design as well as the introduction to relevant mathematics essential to designing systems addressing these needs. Despite being the only required core course, it covers topics that no other courses cover and is a foundational course. Combined with the other courses listed in the program requirements, there will be a clear distinction between this degree and others offered by the school.

The following list of course requirements with a total of 32 credits (same as existing course requirements) will be added to the program. The existing admission requirements, course offerings, delivery method and advising structure will not be modified.

Theory Course (4) - student must take 1 of the following courses:

- SYS 510 Systems Optimization and Design (4)
- SYS 517 Statistical Methods in Engineering (4)
- ISE 530 Engineering Operations Research - Stochastic Models (4)
- APM 563 Applied Mathematics: Discrete Methods I (4)
- MOR 554 Mathematical Programming (4)

Core Courses (12) - student must take the following course:

- SYS 587 Foundations of Systems Engineering I (4)

and at least 2 of the following courses:

- ISE 588 Foundations of Systems Engineering II (4)
- SYS 680 Engineering Decision Analysis (4)
- ISE 520 Engineering Project Management (4)
- ISE 560 Product Lifecycle Management (4)

Systems Elective Courses (8) - student must take 8 credits from the following courses:

Any 500 level or higher SYS course (except SYS 690, SYS 691) or ISE course (except ISE 501, ISE 502, ISE 503, ISE 690, ISE 691)

General Elective Courses/Thesis (8) - student must take 8 credits from one of the following two options:

Course option - 8 credits from any 500 level or higher CSE (except CSE 505, CSE 506, CSE 507, CSE 508), ECE, ISE (except ISE 501,

ISE 502, ISE 503), ME or SYS course (note that the satisfaction of the prerequisites for any given course on this list may depend upon the engineering discipline of the student's B.S. degree).

M.S. Thesis Option - 8 credits of SYS 691. Successful completion and defense of a thesis is a prerequisite for earning thesis credits.

4.1 Please provide a sample program under the proposed requirements.

Due to the flexible nature of the proposed course requirements, there are several ways that a student may select their schedule of courses. One possible example is as follows:

Fall Semester 1:

1. ISE 520 or ISE 680
2. ISE 530 or Systems Elective Course

Winter semester 1:

1. SYS 587
2. ISE 517 or Systems Elective Course

Fall semester 2:

1. ISE 588, ISE 520 or ISE 680
2. Systems Elective Course or General Elective Course

Winter semester 2:

1. ISE 560 or General Elective Course
2. General Elective Course

5. Provide a list of all new courses and deleted courses. Identify and label the course as core, focus (concentration, depth) elective or exit requirement.

No new courses will be added and no current courses will be deleted. The courses that were part of the Systems Engineering track for the Dynamic Systems and Control Engineering Option and Robotics Systems Engineering Option will continue to be offered but will only count towards other master's degrees in the ECE department. Only one course contained in the list of new Systems Engineering course requirements has not been offered recently (ISE 588 Foundations of Systems Engineering II). However, this course will be added to the 2018 fall semester course schedule.

5.1 Do any of the courses being deleted affect other degree programs?

N/A - no courses are being deleted.

6. If any resources needed (personnel, FTE academic, facilities or equipment) please provide budget. If no resources required, please provide a statement in the proposal.

Based on excess capacity in the Systems Engineering courses currently offered by the ISE Dept., it is possible to satisfy this demand for Systems Engineers without the need for additional resources. The proposed Systems Engineering M.S. course requirements include only 1 course that the ISE Dept. is not currently offering, ISE 588 Foundations of Systems Engineering II.

In 2014, the ISE Dept. added a new faculty member, Dr. Pandey, Ph.D. in Systems Engineering. During his first 2 years, Dr. Pandey was granted a one course per semester release to establish his research program. He is now teaching 2 courses per semester starting with the 2016-17 academic year. So the resources needed to offer ISE 588 once per year are already available to the ISE Dept.

7. Funding sources: state sources, federal funds, and other funds as specified.

N/A

8. If the program is professionally accredited, identify the accrediting body and discuss how the proposed change may affect accreditation.

N/A - the Accreditation Bureau for Engineering and Technology (ABET) only accredits the undergraduate or the graduate programs at a university, not both. The SECS has selected to accredit its undergraduate engineering programs (as have over 99% of the engineering schools in the U.S.). The ISE B.S.E. program is ABET accredited in both Industrial Engineering and in Systems Engineering, one of only 5 programs in the U.S. that is accredited in both areas. This speaks toward the existing expertise in Systems Engineering contained in the ISE Dept.

9. Impact on current students, enrollment, time-to-degree, target audience, faculty workload, etc.

There will be no impact due to the proposed modification on any of these areas except for enrollment. We expect the enrollment in the modified Systems Engineer M.S. program to increase from its current level of 9 students (2016 fall semester) to 25-30 students within 3 years. Note this increase can be handled due to excess capacity available in existing courses.

10. Provide explanation for how students enrolled in the program prior to effective date of any curriculum change may complete their program under old requirements – if so desired. The courses required must remain available, or suitable substitutions specifically designated.

Since no existing courses will be deleted, the proposed change will have no impact on existing students in the program. They will be allowed to finish the program and graduate.