

LEVEL II BOARD OF REGENTS ITEMS

1. Overview

A Mechatronics Minor at MSU is being sought

We propose a new Minor in Mechatronics for the students majoring in Mechanical, Electrical, and Computer Engineering (ME, EE, and CpE) at Montana State University. The Minor will complement the ongoing cross-disciplinary activities of the College of Engineering, providing opportunities for students from ME, EE, and CpE departments.

2. Need

a. To what specific need is the institution responding in developing the proposed program?

Mechatronics is an emerging engineering field that has altered the traditional boundaries of engineering education, particularly in the disciplines of mechanical, electrical, and computer engineering. An ever expanding array of products comprising electro-mechanical systems is found in all aspects of our everyday life, ranging from automobiles to home appliances to entertainment systems. The automotive industry, traditionally the domain of mechanical engineering, now incorporates tens of digital microcontrollers into modern vehicle systems such as computer-controlled fuel injection, airbag deployment, antilock brakes, emission controls, and so forth. Vehicles on the drawing board will incorporate still more microcontroller-based technologies in hybrid propulsion, “steer-by-wire”, “brake-by-wire”, collision avoidance, communication and navigation, etc., and automobiles with such capabilities will hit the market in the near future. Mechatronics has already fulfilled the promise of smart, autonomous, electromechanical systems in NASA's Mars Expedition Rover missions currently operating on the surface of Mars. While some of today's most advanced applications are enabled by mechatronics as described above, there are also thousands of important applications that are more commonplace, such as measuring load size in a washing machine using a sensor, transporting paper through a computer printer or photocopier, or reading a microscopic pit track in a DVD player.

The objective of the proposed Minor program is to identify a key set of existing courses in the undergraduate curricula of ME, EE, and CpE, so that interested students can acquire the cross-disciplinary knowledge and skills necessary for product design, development, and manufacturing. Students in the relevant majors do not ordinarily take courses that cross the established discipline boundaries, so the proposed Mechatronics Minor provides a credential recognizing the integration of ME, EE, and CpE, within a contemporary engineering design methodology.

In addition, the state of Montana is engaged in an intense economic development effort focused on technology-based businesses and companies. Among other initiatives, the Montana Legislature created the Montana Board of Research and Commercialization Technology (MBRCT) in 1999 to provide a predictable and stable source of funding for research and commercialization projects. One of the conditions for supporting the proposal

is that the work is to be conducted at research and commercialization centers in Montana. The Mechatronics Minor at MSU will create a critical mass of talent local companies can draw upon as they increase their commercialization efforts.

b. How will students and any other affected constituencies be served by the proposed program?

Based on national and regional demands, several universities have initiated Mechatronics education. Electronic, automotive, and aerospace industries hire many graduates with a Mechatronics background. For example, Department of Mechanical Engineering at Villanova University (VU) (<http://www.villanova.edu/engineering/departments/mechanical/undergrad/mechatronics.htm>) Department of Electrical and Systems Engineering at Washington University (WU) at St. Louis (<http://www.ee.wustl.edu/Academics/mechatronics.asp>) offer Minor in Mechatronics. The Minor offered by WU is primarily designed for students in the Electrical and Systems Engineering and Mechanical and Systems Engineering Departments. The minor program consists of 4 required courses, 2 electives and 1 prerequisite. The course listings are given below:

Four (4) required courses:

1. MASE 255 Engineering Mechanics II [Dynamics]
2. MASE 411 Mechanical Engineering Design Project (Mechatronics project)
3. ESE 446 Robotics: Dynamics and Control
4. ESE 444 Sensors and Actuators

Two (2) electives from the following:

1. MASE 431 Structural Dynamics & Vibration
2. MASE 5101 Fluid Power Systems
3. MASE 4301 Modeling, Simulation and Control or MASE 4302 Aircraft Flight Dynamics and Control or ESE 441 Control Systems
4. ESE 336 Principles of Electronic Devices
5. ESE 442 Digital Control Systems
6. CSE 467S Embedded Computing Systems
7. ESE 482 Digital Signal Processing
8. CSE 550A Mobile Robotics

Prerequisite course:

Basic programming course: CSE 131 or CSE 126 or CSE 200.

To our knowledge, there are no institutions in Montana, Washington, Wyoming, South Dakota, and North Dakota that offer Minor in Mechatronics. Regionally, the University of Utah offers a Certificate in Mechatronics, the University of Washington and Washington State University offer a Degree in Mechanical Engineering with concentration in Mechatronics. Thus, a Minor in Mechatronics at MSU will serve Montana residents and will potentially lower the barrier for students from the other states to choose to attend MSU.

c. What is the anticipated demand for the program? How was this determined?

No explicit analysis of the demand has been conducted, but an interest in Mechatronics is mentioned routinely by prospective students during campus visits, and also in exit interviews with students graduating with majors in ME, EE, and CpE. As was mentioned above, there is an increasing trend among technology sector companies in Montana. Virtually every engineering workplace has become cross-disciplinary in nature in recent years. MSU's College of Engineering is also promoting a cross-disciplinary approach in engineering education and practice. This is explained further in section 3d below.

3. Institutional and System Fit

a. What is the connection between the proposed program and existing programs at the institution?

The proposed Minor is a combination of mechanical, electrical, and computer engineering. Currently, MSU does not have any similar program.

b. Will approval of the proposed program require changes to any existing programs at the institution? If so, please describe.

No new courses need to be developed to start the proposed Minor program. The Minor is designed to utilize existing courses, instructors, and lab facilities.

c. Describe what differentiates this program from other, closely related programs at the institution (if appropriate).

There is no counterpart of this Mechatronics Minor at MSU.

d. How does the proposed program serve to advance the strategic goals of the institution?

This proposed Minor will add to the diverse learning environment of the university as stated in the university's mission statement. Engineering has always been a key component of land grant institutions such as MSU. This proposed Minor will allow engineering students to expand their opportunities and knowledge base to be productive engineers in a wide variety of job descriptions throughout the communities of Montana.

MSU's College of Engineering (COE) has three Strategic Goals for the 2009-2014 period: (1) GLOBAL CONNECTIONS, (2) CROSS-DISCIPLINARY COLLABORATION and (3) TECHNOLOGICAL LEADERSHIP. Based on the cross-disciplinary nature of current work in academia and industry, the proposed Mechatronics Minor is directly aligned to COE's strategy to increase opportunities for cross-disciplinary projects. Moreover, COE has been offering a cross-disciplinary course entitled ENGR 310 since spring 2007. ENGR 310 is required of all ME, EE, and CpE students.

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The proposed Minor is inherently cross-disciplinary because of the combination of major courses in three traditional disciplines (ME, EE, and CpE). The proposed Minor will promote senior design projects with participation by students from different engineering majors. Thus, the Minor in Mechatronics will enhance and complement the ongoing cross-disciplinary activities.

e. Describe the relationship between the proposed program and any similar programs within the Montana University System. In cases of substantial duplication, explain the need for the proposed program at an additional institution. Describe any efforts that were made to collaborate with these similar programs; and if no efforts were made, explain why. If articulation or transfer agreements have been developed for the substantially duplicated programs, please include the agreement(s) as part of the documentation.

To our knowledge, there is no similar program in the Montana University System.

4. Program Details

a. Provide a detailed description of the proposed curriculum. Where possible, present the information in the form intended to appear in the catalog or other publications. NOTE: In the case of two-year degree programs and certificates of applied science, the curriculum should include enough detail to determine if the characteristics set out in Regents' Policy 301.12 have been met.

The students seeking Minor in Mechatronics must *satisfy the degree requirements for an ME, EE or CpE degree* plus the following courses to obtain a Minor in Mechatronics.

Course#	Course Title	Credits	Coreq or Prereq
CS 160	Introduction to Computer Science	4	M 151Q
CS 201	Program Design with C	3	CS 160
EM 251	Statics and Particle Dynamics	3	Phys 211
EM 252	Rigid Body Mechanics	3	EM 251
EM 253	Mechanics of Materials	3	EM 251
ME 117	Mechanical Engineering Design Graphics	1	Permission
ME 118	Mech Eng Design Graphics Lab	1	Permission
ME 320	Thermodynamics I	3	EM 251
ME 326	Fundamentals of Heat Transfer	4	ME 320
EE 261	Introduction to Logic Circuits	3	M 171
EE 262	Logic Circuits lab	1	EE 261
EE 321	Introduction to Controls	4	Permission
EE 371	Microprocessor Hardware and Software System	4	EE 261
	Total	37	

Students pursuing the BS in Mechanical, Computer or Electrical Engineering at MSU will have to take 18-22 additional course credit (including prerequisites) to obtain a Minor in

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Mechatronics. Additional courses need to be taken by ME, EE, and CpE students are tabulated below:

ME Additional Courses:

Course#	Course Title	Credits
CS 160	Introduction to Computer Science	4
CS 201	Program Design with C	3
EE 261	Introduction to Logic Circuits	3
EE 262	Logic Circuits Lab	1
EE 321	Introduction to Controls	4
EE 371	Microprocessor Hardware and Software System	4
Total		19

EE Additional Courses:

Course#	Course Title	Credits
CS 201	Program Design with C	3
EM 252	Rigid Body Mechanics	3
EM 253	Mechanics of Materials	3
ME 117	Mechanical Engineering Design Graphics	1
ME 118	Mech Eng Design Graphics Lab	1
ME 320	Thermodynamics I	3
ME 326	Fundamentals of Heat Transfer	4
Total		18

CpE Additional Courses

Course#	Course Title	Credits
EM 251	Statics and Particle Dynamics	3
EM 252	Rigid Body Mechanics	3
EM 253	Mechanics of Materials	3
ME 117	Mechanical Engineering Design Graphics	1
ME 118	Mech Eng Design Graphics Lab	1
ME 320	Thermodynamics I	3
ME 326	Fundamentals of Heat Transfer	4
EE 321	Introduction to Controls	4
Total		22

b. Describe the planned implementation of the proposed program, including estimates of numbers of students at each stage.

The Mechatronics Minor is primarily applicable to students majoring in Mechanical, Electrical, or Computer Engineering, although students majoring in Computer Science, Industrial Engineering, and Physics could potentially be interested. Thus, it is difficult to state with precision the total number of students who might be interested in the Minor.

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However, it is estimated that a dozen or more students may be enrolled in the Minor shortly after its commencement.

While filing the *Application for Baccalaureate Degree* for the major, students pursuing the Minor in Mechatronics will also have to submit the *Application for a Non-teaching Minor* by the deadlines set forth in the University Catalog. For example, Dr. Ahsan Mian and Dr. Todd Kaiser will serve as the Minor certifying officers for the Mechanical & Industrial Engineering Department and the Electrical & Computer Engineering Department, respectively. They will certify that the M&IE and ECE students have completed the required course credits (as given in Section 4a) for the Minor in Mechatronics.

5. Resources

a. Will additional faculty resources be required to implement this program? If yes, please describe the need and indicate the plan for meeting this need.

Limited additional faculty resources are needed to implement the Mechatronics Minor program. The Minor will be offered within the framework of the current catalogs, curricula, courses, and teaching schedules of the Mechanical and Electrical engineering programs. The College of Engineering is fortunate to have faculty members with the necessary background in the related fields to provide student advising and counseling as part of their regularly assigned advising duties.

We do anticipate that future senior design projects will need to accommodate cross-disciplinary work related to Mechatronics. This additional work by the faculty advisors for the design projects will be handled on a case-by-case basis within the existing senior design rubrics.

b. Are other, additional resources required to ensure the success of the proposed program? If yes, please describe the need and indicate the plan for meeting this need.

The proposed Minor requires limited additional resources, principally to accommodate the inevitable increase in administrative overhead necessary to publicize the program, advise students, and process the *Application for a Non-teaching Minor* paperwork when a student is ready to graduate.

6. Assessment.

How will the success of the program be measured?

M&IE, ECE, and the other departments in the College of Engineering incorporate a systematic assessment plan (<http://www.montana.edu/wwwprov/assessment/assessmentplans.htm>) for all of the academic programs and courses. We continually assess objectives and outcomes at the program and course levels. These assessments are mandatory for our continued national

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accreditation (ABET), and we must demonstrate the assessment and evaluation processes as part of the periodic accreditation review. Therefore, our current assessment plans and evaluation methods will be applied consistently to the Mechatronics Minor.

In addition, we will provide specialized assessment based on student, employer, and alumni satisfaction towards the Minor through appropriate surveys. The M&IE department has been doing this kind of survey for many years to assess the outcomes of the Mechanical Engineering program. Any changes in student enrollment or graduation rate will be monitored, reviewed, and the program will be revised accordingly.

7. Process Leading to Submission

Describe the process of developing and approving the proposed program. Indicate, where appropriate, involvement by faculty, students, community members, potential employers, accrediting agencies, etc.

The present Mechatronics Minor proposal was presented before the departmental Industrial Advisory Boards (IABs) for both the Mechanical & Industrial Engineering and the Electrical & Computer Engineering Departments. Both the IABs were very receptive about the proposal and they responded strongly in favor of the proposal. Several members said that they wish they had the opportunity of having some exposure to mechatronics when they were students at MSU.

The exit interviews of ME graduating seniors show that they feel that the Minor in Mechatronics will add value to our engineering program. Also, this program will allow the students to gather knowledge in control that is necessary for many industrial applications.

The following flow diagram depicts the step-by-step procedure leading to the final approval of the proposed Minor in Mechatronics program at MSU.

