

## MASTER OF ENGINEERING DEGREE MONTANA STATE UNIVERSITY-BOZEMAN

### OVERVIEW

The proposed Master of Engineering Degree Program will be managed through the College of Engineering, Montana State University-Bozeman. The intent of this program is to provide a courses-only Master's degree for students who are currently enrolled as undergraduates in an engineering discipline or for those who wish to continue their education post-graduation from an accredited engineering degree program. Enrolled students will gain additional education to support leadership and management roles in their industry and will also provide a unified degree across the College of Engineering.

This degree program will serve a recognized need for post-baccalaureate education for engineers and satisfy the proposed requirement for 30 credits post-graduation for professional licensure. The M. Eng. will be modeled after the College of Engineering's Ph.D. program, where the degree would be an M.Eng. with various options. These options will be primarily discipline based but will also permit interdisciplinary options that span departmental boundaries.

The proposed program will require a minimum of 30 credits. The program differs from a Plan B Masters in three major respects; there is no required comprehensive exam, the students will be assisted in course selection and program overview by the option coordinator (instead of a traditional three person committee) and that no scholarly project is necessary. Instead, the student will replace the credits taken for the professional project or paper with relevant coursework that will expand their knowledge base in a specific area of expertise. Each option will have a required core set of courses with additional courses selected by the student. In contrast to existing M.S. Plan A or B options which can lead to Ph.D. programs, the M. Eng. degree is seen to be the terminal degree for practicing professionals. The new degree title would clearly differentiate a research/professional project degree (Master of Science) from this courses-only program (Master of Engineering).

This degree program is not unique; there are many other institutions that offer a similar degree. For example, North Dakota State University has a courses-only M. Eng. <http://www.und.edu/dept/registrar/catalogs/catalog/graddept/depts/che.htm> as does the University of Illinois Chicago(<http://www.uic.edu/eng/meng/>), Michigan Tech (<http://www.doe.mtu.edu/masteng.htm>) and Northern Arizona University (<http://www.cefns.nau.edu/Academic/MEng/>).

### NEED

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

The program addresses two specific needs. The first is that the program would be an opportunity for MSU's College of Engineering to provide the education that is likely to be required for practicing engineers to attain the title of Professional Engineer in Montana. Engineers must take and pass an examination to be granted this title. To sit for the exam, engineers must meet the requirements listed in the Model Law of the National Council of Examiners for Engineering and Surveying. In 2006 the NCEES adopted a requirement that engineers must have 30 credits post-baccalaureate degree in addition to other prerequisites, and this would be enacted in 2015 ([http://www.ncees.org/news/index.php?release\\_id=1](http://www.ncees.org/news/index.php?release_id=1)). More

recently, there has been a proposed amendment that this be moved to 2020, but states and governing boards are being urged to enact this by 2012 to be in compliance. Nebraska and Wyoming have already put this amendment to the Model Law into practice. Specific wording in this amendment relative to this degree proposal is:

*Professional Engineer or Professional Surveyor—To be eligible for admission to the examination for professional engineers or professional surveyors, an applicant must be of good character and reputation and shall submit five references acceptable to the board with his or her application for licensure, three of which references shall be professional engineers or professional surveyors having personal knowledge of the applicant's engineering or surveying experience.*

1. *As a Professional Engineer—The following shall be considered as minimum evidence satisfactory to the board that the applicant is qualified for licensure as a professional engineer.*
  - c. *Licensure by Examination (Effective January 1, 2020)—The following individuals shall be admitted to an eight-hour written examination in the principles and practice of engineering:*
    - (1) ***An engineer intern with a bachelor's degree, with an additional 30 credits of acceptable upper-level undergraduate and/or graduate-level coursework from approved course providers, and with a specific record of four years or more of progressive experience on engineering projects of a grade and a character which indicate to the board that the applicant may be competent to practice engineering.***
    - (2) ***An engineer intern with a master's degree in engineering from an institution that offers EAC/ABET-accredited programs, or the equivalent, and with a specific record of three years or more of progressive experience on engineering projects of a grade and a character which indicate to the board that the applicant may be competent to practice engineering.***

(bolding provided to illustrate compliance of proposed degree program with the Model Law)

Note that this revision to the Model Law precludes students who do not have the 30 extra credits post baccalaureate or M.S. degree from sitting for the exam to be licensed as a professional engineer. Although the Model Law has not yet been implemented in Montana, there is every reason to believe that it will be.

The concept of a courses-only M. Eng. degree was proposed by engineering faculty to meet this need and also in response to requests from current students as well as practicing engineers in Bozeman who wish to take more coursework but do not want to devote the time to completing a research project (Plan A) or professional paper (Plan B) for the Master of Science degrees offered in Engineering. This plan was strongly endorsed by several of the College's Engineering Advisory Boards.

The proposal also meets faculty needs by reducing the amount of oversight required for each student ; Plan A and B M.S. students must have focused mentoring from a faculty advisor for completion of the research or professional project, while students who are in the courses-only M.Eng. program would be more student-directed. The M. Eng. program also give the faculty the flexibility to design multidisciplinary degree programs that meet the needs of students in a changing work environment.

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

In addition to the probable requirement for additional credits prior to professional licensure for engineers, there is a need for continued education from the student's perspective. There are students who desire additional coursework or areas of specialization in engineering that go beyond what can be provided in our accredited undergraduate curriculum. There are also graduates in the community who wish to acquire more knowledge in a specific area of engineering. These students can enroll in a program that will give them the opportunity to obtain this in-depth expertise.

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

When the Model Law is adopted, there will be a requirement for engineers to have 30 credits in addition to their B.S. degree to become licensed as professional engineers. MSU must respond to this requirement in advance so that current students can proactively take this coursework. This program will also give practicing engineers who wish to become licensed the opportunity to acquire the credits they will need. Implementation of the program now will ensure that our graduates are prepared to seek licensure when they have fulfilled their other work-related obligations. Demand was also assessed as per input from the College's advisory boards. Faculty responsible for the individual options project 5-10 new students per year per option.

#### **INSTITUTIONAL AND SYSTEM FIT**

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

The proposed program will be integrated with the existing M.S. programs in Engineering at Montana State University-Bozeman. The primary difference will be the lack of a research or professional project and the requirement for more coursework to complete the 30 credit degree. Courses are already in existence to support the students. The M. Eng. program will benefit existing graduate programs by enhancing student enrollment. In some curricula, the graduate enrollments are small which necessitates graduate courses being offered on demand on every other year. This can increase the amount of time to graduation for students in traditional M.S. and Ph.D. degrees. The new M. Eng. degree would help populate these courses so they could be offered routinely. The format of the M. Eng. program would mirror the successful Ph.D. in Engineering offered at MSU-Bozeman, where students select a home department and then pursue one of seven options in applied mechanics or environmental, civil, mechanical, industrial, electrical/computer, and chemical engineering. The Ph.D. program has two cross-departmental options (environmental engineering and applied mechanics) and it is anticipated that other cross-departmental M. Eng. options would be developed.

- b. Will approval of the proposed program require changes to any existing programs at the institution?

The courses-only Master of Engineering program will not require changes to any existing programs at MSU-Bozeman.

- c. Describe what differentiates this program from other, closely related programs at the institution.

The Master of Engineering program is complimentary to the Master of Science degrees at MSU-Bozeman but serves a different purpose. The M. Eng. program specifically addresses the requirement for continuing education and depth of expertise in a field of engineering for the practicing engineer or the engineering student who wishes to focus their engineering in an application area. The M. Eng. degree is expected to be the terminal degree, while the M.S. degree may be intermediate between the B.S. and Ph.D.

There has also been the stated desire of faculty to have the courses-only degree (M. Eng.) differentiated from the traditional M.S. degrees so that students and employers will recognize that the former does not include an independent research or creative project activity.

Another difference is that coursework for M.S. degrees is typically decided by the student and major advisor, while the M.Eng. student will be required to take a suite of core courses for each option with others chosen from a list of option specific courses.

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

The mission of the College of Engineering at Montana State University is to serve the State of Montana and the nation by fostering lifelong learning, integrating learning and discovery, developing and sharing technical expertise, and empowering students to be tomorrow's leaders. The strategic goals of the COE for 2009-2014 are to:

1. Prepare the MSU COE community to engage effectively with the global community.
2. Build on growing college synergy and increase cross-disciplinary activities at every level of the COE community, including not only faculty research and creative activity, but also the student experience.
3. Establish the college as a leader in the state and national technological community.

The proposed M. Eng. program integrates well with the mission of the COE and the new strategic goals. In particular, it focuses on fostering lifelong learning by providing a degree option for practicing professionals who do not have the need to engage in research or a project. By participating in coursework with faculty who are at the cutting edge of technology, M. Eng. students will be exposed to the current advances in the various options. The program certainly fits with the mission of empowering students to become leaders in their area of expertise. The M. Eng. program is also in line with the COE's strategic goals, particularly with the desire to become a leader in the state and nation's technology community.

The program also fits with MSU-Bozeman's 2008-2014 five year strategic plan. In particular, it directly addresses goal #5 - integration of Montana State University into the fabric of the state and beyond – where there is mention of workforce development programs. This degree program specifically addresses this point by providing essential continuing education for Montana's practicing engineers.

Additionally, the program meets two components of the Montana Board of Regents strategic plan. Goal I, *Increase educational attainment of Montanans* has subsection (5), which is to *increase enrollment of traditional and non-traditional students*. The M. Eng. program will encourage current B.S. students in engineering to seek an advanced degree and will also be an avenue for practicing professionals to take relevant coursework to advance their careers. It also contributes to Goal II, *Assist in the expansion and improvement of the economy* through subsection (1) *increase responsiveness to workforce development*.

- e. Describe the relationship between the proposed program and any similar programs within the Montana University System.

There is no significant overlap with any program in the MUS system.

### **PROGRAM DETAILS**

- a. Provide a detailed description of the proposed curriculum

There are two major curricular/program components that distinguish the M. Eng. from the M.S. degree, and these differences are the rationale for seeking a new degree that clearly defines the two programs. The first difference is that there is no professional paper or thesis required for the M. Eng. M. Eng. students are those who are either practicing engineers or continuing students who wish to acquire the credits required for professional licensure. In the first case, the students have experience in practical engineering and the concepts that would be involved in a capstone experience. In the latter case, all senior engineering students have completed a senior design project that is of the same depth as most professional papers, and this is also true of practically all accredited undergraduate engineering programs. Additionally, elimination of the thesis or professional paper provides the opportunity for more coursework in an area of interest to the student. The second differentiating element between the M.S. and the M. Eng. is that there is no requirement for a comprehensive examination at the end of the degree program. Because this is a courses-only degree and there is a requirement that students maintain a 3.0 GPA, there will be no further proof of proficiency. This is consistent with other similar programs across the country where the intent is to provide education for practicing professionals. Admission requirements will be equivalent to other Master's programs in the COE and are in alignment with the Division of Graduate Education's general provisions with the exception that the GRE is required for admission. Students will be accepted by established departmental criteria.

Students will be supervised by an option coordinator as opposed to oversight by a three member committee typical for M.S. degrees.

Addition of new options and review of the programs will be facilitated through the College of Engineering by the Associate Dean for Research and Graduate Studies and a College-wide committee consisting of option coordinators. Any new degree options will be established by the faculty and presented to the committee for review and inclusion into the M. Eng. program. General oversight of the curriculum in each option will be guided by the faculty involved in that option.

Initially, the degree will be provided in four options. The curriculum for each option was created by the faculty in that area and brought to the committee for review.

### ***M.Eng. in Chemical Engineering***

#### *General Requirements:*

- 30 credits total
- At least 18 of the total credits required for degree must be at 5xx level
- 3xx level courses are not allowed
- 4xx level courses may be used

- Courses with grades below C- cannot be used to satisfy graduation requirements
- Three credits (min.) registration required during term of graduation (1 credit with in absentia graduation request on file)

*Course Requirements:*

The following courses are required of each MEng/CHE student:

- CHBE 500: Graduate Seminar (1 cr, can be taken twice)
- CHBE 503: Thermodynamics (3 cr)
- CHBE 530: Transport Phenomena (3 cr)

Plus, a course in each of the following areas:

- Reaction Engineering (3 cr), CHBE 510 or another reactions course (e.g., ENVE 566 Biofilms)
- Numerical Analysis (3 cr), CHBE 525 or another advanced engineering mathematics course (e.g., CHBE 522)

***M. Eng. in Bioengineering***

*General Requirements:*

- 30 credits total
- At least 18 of the total credits required for degree must be at 5xx level
- 3xx level courses are not allowed
- 4xx level courses may be used
- Courses with grades below C- cannot be used to satisfy graduation requirements
- Three credits (min.) registration required during term of graduation (1 credit with in absentia graduation request on file)

*Course Requirements*

The following courses are required of each MEng/BIOE student:

- CHBE 500: Graduate Seminar (1 cr, can be taken twice)
- ENVE 566 Biofilms (3 cr)
- CHBE 530: Transport Phenomena (3 cr)

Plus, a course in each of the following areas:

- Numerical Analysis (3 cr), CHBE 525 or another advanced engineering mathematics course (e.g., CHBE 522)
- ENVE 560: Environmental Engineering Processes or other 500 level Biological course appropriate to the student's focus

***M. Eng. in Mechanical Engineering***

*General Requirements:*

- Undergraduate degree in Mechanical Engineering or closely related field
- 30 credits total
- At least 18 of the total credits required for degree must be at 5xx level
- 3xx level courses are not allowed
- 4xx level courses may be used if they have not been used for another degree
- Courses with grades below C- cannot be used to satisfy graduation requirements
- No Pass/Fail credits are allowed
- A maximum of 6 credits of ME570 (Individual Problems) may be used

- Three credits (min.) registration required during term of graduation (1 credit with in absentia graduation request on file)

*Course Requirements:*

The following courses are required of each M. Eng./ME student:

- ME 510: Advanced Engineering Analysis I (3 cr)
- ME 511: Advanced Engineering Analysis II (3 cr)
- EM 525: Continuum Mechanics (3 cr)

Plus, a Mechanical Engineering course in each of the following areas:

- Materials (3 cr)
- Thermo/Fluids (3 cr)
- Solid Mechanics (3 Cr)

***M. Eng. in Electrical Engineering***

*General Requirements:*

- 30 credits total
- At least 18 of the total credits required for degree must be at 5xx level
- 3xx level courses are not allowed
- 4xx level courses may be used
- Courses with grades below C- cannot be used to satisfy graduation requirements
- Three credits (min.) registration required during term of graduation (1 credit with in absentia graduation request on file)

*Course Requirements:*

At least 15 credits must come from within one area of specialization:

- Electronic Devices & MEMS
- Telecommunication
- Signals & Controls
- Power & Energy
- Electromagnetics & Optics

The remaining courses must come from the approved list of 400 and 500-level courses.

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

Implementation for the proposed program is straight-forward. Upon approval of the degree, option coordinators will be assigned. Because no new classes are required and the degrees are designed to be compatible with current graduate course and admission structures, students can be admitted immediately. In addition to recruiting current MSU engineering students, potential students in Montana businesses will be made aware of the program through alumni email lists. The information will also be given to the department and college advisory boards. Each option anticipates five to ten students admitted each year. This number fits with the current course capacity and with the intent to increase graduate enrollment in currently offered classes.

**RESOURCES**

No new resources will be required for the implementation of the M. Eng. program.

- a. Will additional faculty resources be required to implement this program?

Additional faculty resources will not be needed as the options will utilize existing courses.

- b. Are other additional resources required to ensure the success of the proposed program?

No other resources are required because the basic infrastructure to support this program already exists.

## **ASSESSMENT**

- a. How will the success of the program be measured?

Success of the program will be initially based on the number of students admitted into the M. Eng. program. This includes the number of students who are returning for the degree post-baccalaureate. The primary indicator will be the number of students who successfully complete the degree, but this may take several years, especially if the students who enroll are from industry and take one or two courses a year while employed. Input will also be sought from the advisory boards and their impressions of the usefulness of the program.

## **PROCESS LEADING TO SUBMISSION**

The concept of an M. Eng. degree took hold two years ago in a College-wide conversation held with faculty involved with graduate education. The group expressed a desire to cater to the needs of the engineering profession as perceived by changes in the Model Law. Subsequent to this meeting, departments received input from their Advisory Boards that this type of degree was desirable. Additionally, there was input from engineers in the community who wished to have access to continuing education (coursework only) without the need to complete a professional paper. The faculty met and decided that there should be a clear distinction in the degree title (M. Eng.) for a coursework only program that delineated it from traditional M.S. degrees. A committee of potential option coordinators representing all of the disciplines in the College met to discuss the outlines for the degree. This was followed by a rough outline of this document, which was then taken by each option coordinator to their departmental faculty for input and creation of the curricula. In the interim, the committee considered umbrella policies including entrance requirements, the replacement of the traditional committee with the option coordinator, and elimination of the comprehensive examination. Subsequent versions of the plan were vetted to the committee. The plan was taken to MSU's Graduate Council and the COE's Department Heads for review prior to submission to the Vice Provost for Graduate Education.