

# The University Senate of Michigan Technological University

## Proposal 12-12 (Voting Units: Academic)

### Proposal for New Undergraduate Degree “B.S. in Engineering Management”

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#### 1. General description and characteristics of program.

The School of Business and Economics proposes a new degree: B.S. in Engineering Management. This new degree is a rigorous and challenging degree that satisfies the demand for graduates who can be successful in technologically oriented businesses by bridging the business and engineering or technical aspects of the firm. Students complete courses in engineering, math, and science while completing a comprehensive business curriculum. Students develop a broad and strategic perspective of business, acquire a solid command of the technical fundamentals of engineering, and link their technological skills with their business knowledge through the required senior capstone business development experiences courses (BUS 4991 – Business Development I and BUS 4992 – Business Development II).

#### 2. Rationale.

This degree is designed to satisfy the growing needs in industry and our economy for individuals with strong skills in both business and engineering. Graduates of this degree will be prepared to work in businesses which require individuals to understand rapid technological changes while meeting and advancing the organization’s business needs. Graduates will be able to fulfill a variety of entry-level business roles including project manager, product manager, production supervisor, technical sales, business process analyst, manufacturing manager, field service manager, and technical customer relations manager. Graduates will be prepared for entrepreneurial-related activities with the mix of business and technical knowledge and the required Business Development Experiences

This new degree program will help Michigan Tech achieve its Strategic Plan by “Deliver[ing] a distinctive and rigorous discovery-based learning experience grounded in science, engineering, technology, sustainability, the business of innovation, ...” (Michigan Tech *Strategic Plan*, <http://www.mtu.edu/stratplan/>). Additionally, this new degree helps the School of Business and Economics fulfill its mission to “... integrate[s] the University's technological prominence with experience-based learning to develop leaders in global business and innovation ...” (School of Business and Economics *Mission*, <http://www.mtu.edu/business/school/dean/mission-values/>).

#### 3. Discussion of related programs within the institution and at other institutions.

~~There are no related programs within Michigan Tech.~~ **Currently there is only one similar curriculum focusing on the design and management of engineering systems which is offered through the Bachelor of Science in Engineering program.** However, thirteen related degree programs have been identified at other universities (see Appendix 1). Two of these programs are in business schools we have designated as “Comparable Peers” for our accreditation through AACSB International—The Association to Advance Collegiate Schools of Business (Clarkson University, University of Vermont), and one of these programs is in a business school in our “Aspirant Group” (Lehigh University) for our AACSB accreditation.

#### 4. Projected enrollment.

Enrollment projection for this degree is expected to be between 30 and 40 new (single degree, non-dual degree) students within three years of program commencement. We expect the majority of these students to be new (net gain) students. The remaining students will be internal transfers. That is, we expect to experience internal transfers consistent with other existing programs and, therefore, enhance student retention.

#### 5. Scheduling plans (Extension, Evening, Regular).

This degree will be offered on campus similar to the other undergraduate degrees offered by the School of Business and Economics.

#### 6. Curriculum design (refer to format of degree audit form). Indicate subject areas to be used for Departmental GPA calculation.

This degree provides students a balanced undergraduate educational foundation in math and science and building on this foundation to provide further education in business and engineering. Engineering principles and technical problem-solving is stressed together with a comprehensive business education comprising a business core, additional business courses (“business focus”) in finance, marketing, operations, and management, and an engineering focus. The degree program concludes with a senior-year Business Development Experience (<http://www.mtu.edu/business/undergrad/business-development-experiences/>) whereby these students will be writing a business or commercialization plan for emerging technologies as members of College of Engineering Senior Design Teams or Enterprise teams.

A credit summary is below along with the curriculum for each category. The degree requires a minimum of 128 credit hours. The “free electives” are variable to allow the student to reach the 128 minimum. Details in each specific course in the curriculum is provided in Appendix 2).

|                       |         |
|-----------------------|---------|
| General Education     | 13      |
| HASS                  | 15      |
| Math                  | 13 - 16 |
| Science               | 8       |
| Business Core         | 36      |
| Business Electives    | 9       |
| Engineering Core      | 16 - 17 |
| Engineering Electives | 10 - 13 |
| Free Electives        | 1 - 8   |

### Math

|   |         |                               |   |
|---|---------|-------------------------------|---|
| Y | MA 1160 | Calculus with Technology I    | 4 |
|   | or      |                               |   |
|   | MA 1161 | Calculus Plus w/ Technology I | 5 |
| Y | MA 2160 | Calculus with Technology II   | 4 |
| Y | MA 2320 | Elementary Linear Algebra     | 2 |
|   | or      |                               |   |
|   | MA 2321 | Elementary Linear Algebra     | 2 |
|   | or      |                               |   |
|   | MA 2330 | Elementary Linear Algebra     | 3 |
| Y | MA 2720 | Statistical Methods           | 4 |
|   | or      |                               |   |
|   | MA 3710 | Engineering Statistics        | 3 |

## Science

|         |                                |   |
|---------|--------------------------------|---|
| PH 1100 | Physics by Inquiry I           | 1 |
| PH 2100 | University Physics I-Mechanics | 3 |
| CH 1150 | University Chemistry I         | 3 |
| CH 1151 | University Chemistry I Lab     | 1 |

## Business Core

|          |   |   |
|----------|---|---|
| ACC 2000 | Accounting Principles I                 | 3 |
| ACC 2100 | Accounting Principles II                | 3 |
| FIN 3000 | Principles of Finance                   | 3 |
| MKT 3000 | Principles of Marketing                 | 3 |
| MGT 3000 | Organizational Behavior                 | 3 |
| MIS 2000 | IS/IT Management                        | 3 |
| BUS 2200 | Business Law                            | 3 |
| OSM 3000 | Operations Management                   | 3 |
| MGT 4000 | Strategic Management                    | 3 |
| MGT 4600 | Management of Technology and Innovation | 3 |
| BUS 4991 | Business Development I                  | 3 |
| BUS 4992 | Business Development II                 | 3 |

## Business Electives

Accounting, Economics, Finance (Choose one)

|          |                                       |   |
|----------|---------------------------------------|---|
| ACC 3500 | Managerial/Cost Accounting I          | 3 |
| EC 3100  | International Economics               | 3 |
| FIN 4000 | Investment Analysis                   | 3 |
| FIN 4100 | Advanced Financial Management         | 3 |
| FIN 4200 | Derivatives and Financial Engineering | 3 |

|          |   |   |
|----------|---|---|
| FIN 4500 | Financial Risk Management and Financial Engineering | 3 |
| FIN 4700 | Global Finance                                      | 3 |

Marketing (Choose one)

|          |                            |   |
|----------|----------------------------|---|
| MKT 3600 | Marketing Research         | 3 |
| MKT 4000 | New Product Marketing      | 3 |
| MKT 4100 | Sales and Sales Management | 3 |
| MKT 4300 | Global Marketing           | 3 |

Operations and Systems Management (Choose one)

|          |   |   |
|----------|---|---|
| OSM 3200 | Project Management                                  | 3 |
| OSM 4300 | Project Planning and Management for Decision Making | 3 |

## Engineering Core

|          |  |   |
|----------|--|---|
| ENG 1101 | Engineering Analysis and Problem Solving | 3 |
| ENG 1102 | Engineering Modeling and Design          | 3 |

Pick 3 of the following

|          |   |   |
|----------|---|---|
| ENG 2120 | Statics-Strength of Materials                     | 4 |
| ENG 3200 | Thermodynamics/Fluid Mechanics                    | 4 |
| EE 3010  | Circuits and Instrumentation                      | 3 |
| MY 2100  | Introduction to Materials Science and Engineering | 3 |

## Engineering Electives (choose one area of study)

### General

|  |       |
|--|-------|
| ENG 2120 or ENG 3200 or EE3010 or MY 2100        | 3-4   |
| MEEM 2500 Integrated Design and Manufacturing    | 4     |
| MY 4800 Material and Process Selection in Design | 3     |
|  | 10-11 |

### Biomedical Engineering

|  |       |
|--|-------|
| ENG 2120 or ENG 3200 or EE3010 or MY 2100      | 3-4   |
| BE 2400 Biology for Engineers I                | 3     |
| BE 2600 Introduction to Biomedical Engineering | 3     |
| BE 3500 Biomedical Materials                   | 3     |
|  | 12-13 |

### Civil Engineering

|  |    |
|--|----|
| CE 3101 Civil Engineering Materials              | 3  |
| CE 3202 Structural Analysis                      | 3  |
| CE 3332 Fundamentals of Construction Engineering | 3  |
| CE 3401 Transportation Engineering               | 3  |
|  | 12 |

### Electrical Engineering

|   |    |
|---|----|
| EE 2174 Digital Logic and Lab                 | 4  |
| EE 3120 Electric Energy Systems*              | 3  |
| EE 3171 Microcontroller Applications and Lab  | 4  |
| *requires EC 3010 as part of Engineering Core | 11 |

### Energy Engineering

|   |    |
|---|----|
| PH 2200 University Physics II-Electricity and Magnetism | 3  |
| MEEM 4200 Principles of Energy Conversion               | 3  |
| EE 3120 Electric Energy Systems*                        | 3  |
| CM 3974 Fuel Cell Fundamentals                          | 1  |
| CM 3977 Fundamentals of Hydrogen as an Energy Carrier   | 1  |
| CM 3978 Hydrogen Measurements Lab                       | 1  |
| *required ECE 3010 as part of the Engineering Core      | 12 |

## Environmental Engineering

|  |   |    |
|--|---|----|
| ENVE 3503 Environmental Engineering                                  | 3 |    |
| ENVE 4505 Surface Water Quality Engineering                          | 3 |    |
| ENVE 4506 App of Sustain Princip & Env. Regs to Engineering Practice | 3 |    |
| ENVE 4508 Water and Wastewater Treatment                             | 3 | 12 |

## Geological Engineering

|   |   |    |
|---|---|----|
| GE 2000 Understanding the Earth or GE2100 Environmental Geology | 3 |    |
| GE 3850 Geohydrology  | 3 |    |
| CE 3810 Soil Mechanics for Engineers                            | 3 |    |
| One from the following:   |   |    |
| GE 4610 Formation Evaluation and Petroleum Engineering          | 3 |    |
| GE 4800 Groundwater Engineering                                 | 3 |    |
| GE 4860 Computer Methods in Geomechanics                        | 3 | 12 |

## Material Science and Engineering

|   |   |    |
|---|---|----|
| MY 4300 Mechanical Behavior of Materials              | 3 |    |
| MY 4800 Material and Process Selection in Design      | 3 |    |
| Two from the following                                |   |    |
| MY 4190 Env. Eng. for Materials Processing Industries | 3 |    |
| MY 4600 Introduction to Polymer Engineering           | 3 |    |
| MY 4130 Principles of Metal Casting                   | 3 |    |
| MY 4155 Composite Material                            | 3 | 12 |

## Mechanical Engineering

|   |   |  |
|---|---|--|
| MEEM 2500 Integrated Design and Manufacturing | 4 |  |
| MEEM 4150 Intermediate Mechanics of Materials | 3 |  |
| MEEM 4200 Principles of Energy Conversion*    | 3 |  |

\*requires ENG 2120 as part of Engineering Core 10

## Mining Engineering:

|                                     |   |    |
|-------------------------------------|---|----|
| GE 2000 Understanding the Earth     | 3 |    |
| GE 2020 Intro to Mining Engineering | 3 |    |
| GE 3400 Drilling and Blasting       | 3 |    |
| GE 4360 Materials Handling          | 3 | 12 |

## Petroleum Engineering:

|  |   |    |
|--|---|----|
| GE 2000 Understanding the Earth                        | 3 |    |
| GE 3050 Structural Geology                             | 3 |    |
| GE 3200 Geochemistry                                   | 3 |    |
| GE 4610 Formation Evaluation and Petroleum Engineering | 3 | 12 |

## Transportation Engineering

|                                     |   |    |
|-------------------------------------|---|----|
| CE 3401 Transportation Engineering  | 3 |    |
| CE 4402 Traffic Engineering         | 3 |    |
| CE 4404 Railroad Engineering        | 3 |    |
| CE 4406 Airport Planning and Design | 3 | 12 |

## General Education and HASS

**General Education Requirements**

|                     |                |   |           |
|---------------------|----------------|---|-----------|
| UN 1001             | Perspectives   | 3 |           |
| UN 1002             | World Cultures | 4 |           |
| UN 2001             | Composition    | 3 |           |
| UN 2002             | Institutions   | 3 |           |
| <i>Credit Total</i> |                |   | <b>13</b> |

**HASS Distribution Courses**

|   |                         |   |           |
|---|-------------------------|---|-----------|
| <i>No more than 3 credits from HASS Creative Endeavors List may be used</i> |                         |   |           |
| <i>No more than 3 credits from the HASS Supplemental List may be used.</i>  |                         |   |           |
| EC 2001   | Principles of Economics | 3 |           |
|   |                         |   |           |
|   |                         |   |           |
|   |                         |   |           |
|   |                         |   |           |
| <i>Credit Total</i>   |                         |   | <b>15</b> |

7. New course descriptions. (New Course Add Forms are needed for each course and will be processed upon final approval of program.)

No new courses are proposed. All courses are existing courses.

8. Library and other learning resources.

The library and other learning resources will be the same as those for current students.

9. Computing Access Fee.

Technology fees for this degree will be the same as for other undergraduate degrees offered by the School of Business and Economics.

10. Faculty resumes (a web site link is sufficient).

All courses in the curriculum are existing courses and, therefore, existing School faculty will be involved in this degree. A School faculty directory can be found at <http://www.mtu.edu/business/school/faculty-staff/faculty/>.

11. Description of available/needed equipment.

No new equipment is required.

12. Program costs, years 1, 2, and 3. (Additional information may be requested by the Senate Finance Committee.)

The workload of existing staff within the School of Business and Economics will increase due to advertising, administrating and advising duties related to the major. However, overall undergraduate enrollment in the School of Business and Economics has declined since its peak in Fall 2005 with 475 students to the current Fall 2011 enrollment of 399 students. Adjusting course schedules has resulted and the School is in a position to take on the expected increase in enrollment from this new degree without adding new faculty lines.

13. Space.

As explained in point 12 above, classes are under capacity. Moving to central IT enables access to computer labs across campus to sufficiently handle these students.

14. Policies, regulations and rules.

(Not applicable)

#### 15. Accreditation requirements.

This degree program will become part of our AACSB accreditation. All necessary AACSB accreditation requirements (including assessment and recording of academic qualification of faculty) will be maintained and documented at program commencement. The degree will be formally assessed during the next AACSB Peer-Review Team visit in the 2015-16 academic year.

#### 16. Internal status of the proposal.

This proposal developed in the following sequence:

- Academic Year 09-10: Graduates of Michigan Tech expressed to the Dean of the School of Business and Economics the need for a degree that would provide both business and engineering knowledge and skills. The Dean presents and discusses the idea to the School's Dean's Advisory Council.
- Fall 2010: A rough draft of the degree program is drafted by the Dean of the School of Business and Economics and presents the idea to the Dean of the College Engineering who recommends College of Engineering Associate Dean Leonard Bohmann as the contact for this program. The Dean of the School of Business and Economics discusses the draft with Associate Dean Leonard Bohmann who presents the degree program for discussion in their College Council.
- Spring 2011: Feedback from the College Council is incorporated into the proposal which includes changes to the engineering courses in the curriculum as originally proposed. (Communication on specific courses in engineering was mainly between Dean Darrell Radson and Associate Dean Leonard Bohmann).
- Fall 2011: Draft proposal is discussed by the School of Business and Economics Undergraduate Program Committee and the School faculty. Suggestions and proposed changes are incorporated. The proposal is approved by the School's Undergraduate Program Committee and faculty in accordance to the School's Charter. Additional refinements to the engineering electives are added as suggested by Associate Dean Leonard Bohmann and department chairs.
- Fall 2011: Proposal approved by the School of Business and Economics faculty is submitted to the Provost. The Provosts presents the proposal to the Dean's Council by the Provost and approved.
- Spring 2012: Proposal discussed by the University Senate and appropriate subcommittees.

#### 17. Planned implementation date.

Fall 2012

### **Appendix 1: Related programs at other universities.**

| University                                    | Degree   | College/School   | Accreditation |
|---|--|--|---------------|
| Clarkson University                           | M.S. Engineering and Management  | School of Business   | AACSB         |
| Drexel University                             | M.S. Business and Engineering  | Drexel College of Business   | AACSB         |
| Kellogg University                            | M.S. Business and Engineering  | The College of Business and Economics<br>The P. C. Rossin College of Engineering and Applied Science | AAACSB        |
| Missouri University of Science and Technology | M.S. Engineering Management  | Department of Engineering Management and Systems Engineering   | ABET          |
| Rensselaer Polytechnic Institute              | M. S. Industrial and Management Engineering                                    | School of Engineering  | ABET          |
| Stevens Institute of Technology, NJ           | M.S. Engineering Management  | School of Systems and Enterprises  | ABET          |
| United States Military Academy, NY            | M.S. Engineering Management  | Department of Systems Engineering  | ABET          |
| University of Arizona                         | M.S. Engineering Management  | College of Engineering   | ABET          |
| University of Connecticut                     | M. S. Management and Engineering for Manufacturing                             | School of Business Administration and School of Engineering  | ABET          |
| University of Illinois - Chicago              | M.S. Engineering Management  | College of Engineering and the College of Business Administration                                    | AAACSB        |
| University of Texas, Austin                   | Master of Business Administration with a Major in "Engineering Based Business" | McCombs School of Business   | AAACSB        |
| University of the Pacific, CA                 | M.S. Engineering Management  | School of Engineering and Computer Science   | ABET          |
| University of Vermont                         | M.S. Engineering Management  | College of Engineering and Mathematical Sciences and the School of Business Administration           | AAACSB        |

Yonkers University of the Americas: AACSB Accredited

## Appendix 2: Courses in the Curriculum

### Math

**MA 1160 - Calculus with Technology I** An introduction to single-variable calculus, which includes a computer laboratory. Topics include trigonometric, exponential, and logarithmic functions, differentiation and its uses, and basic integration. Integrates symbolic tools, graphical concepts, data and numerical calculations. **Credits:** 4.0 Lec-Rec-Lab: (0-4-0) **Semesters Offered:** Fall, Spring **Pre-Requisite(s):** MA 1032 or MA 1031 or ACT Mathematics  $\geq$  29 or SAT Mathematics  $\geq$  650 or

**MA 1161 - Calculus Plus w/ Technology I** An introduction to single-variable calculus, which includes a computer laboratory. Topics include trigonometric, exponential, logarithmic functions, differentiation and its uses, and basic integration. Integrates symbolic tools, data and numerics, and graphical concepts and is

similar to MA1160, going at a slower pace and incorporating cooperative learning study skills. **Credits:** 5.0 **Lec-Rec-Lab:** (0-5-0) **Semesters Offered:** Fall, Spring, Summer **Pre-Requisite(s):** MA 1032 or MA 1031 or ACT Mathematics  $\geq$  26 or SAT Mathematics  $\geq$  600

**MA 2160 - Calculus with Technology II** Continued study of calculus, which includes a computer laboratory. Topics include integration and its uses, function approximation, vectors, and elementary modeling with differential equations. **Credits:** 4.0 **Lec-Rec-Lab:** (0-4-0) **Semesters Offered:** Fall, Spring, Summer **Pre-Requisite(s):** MA 1160 or MA 1161 or MA 1135

**MA 2320 - Elementary Linear Algebra** An introduction to linear algebra and how it can be used. Topics include systems of equations, vectors, matrices, orthogonality, subspaces, and the eigenvalue problem. Not open to students with credit in MA2321 or MA2330. **Credits:** 2.0 **Lec-Rec-Lab:** (0-2-0) **Semesters Offered:** Fall, Spring, Summer **Restrictions:** May not be enrolled in one of the following Major(s): Mathematics, Computer Science **Pre-Requisite(s):** MA 1160 or MA 1161

or  
**MA 2321 - Elementary Linear Algebra** Offered first half of semester, to be taken concurrently with MA3521. The course is an introduction to linear algebra and how it can be used. Topics include systems of equations, vectors, matrices, orthogonality, subspaces and the eigenvalue problem. Not open to students with credit in MA2320 or MA2330. **Credits:** 2.0 **Lec-Rec-Lab:** (0-4-0) **Semesters Offered:** Fall, Spring **Restrictions:** May not be enrolled in one of the following Major(s): Mathematics, Computer Science **Co-Requisite(s):** MA 3521 **Pre-Requisite(s):** MA 2160

or  
**MA 2330 - Introduction to Linear Algebra** An introduction to linear algebra and how it can be used, including basic mathematical proofs. Topics include systems of equations, vectors, matrices, orthogonality, subspaces, and the eigenvalue problem. Not open to students with credit in MA2320 or MA2321. Course prerequisite is any math class numbered MA1090 or higher. **Credits:** 3.0 **Lec-Rec-Lab:** (0-3-0) **Semesters Offered:** Fall, Spring **Pre-Requisite(s):** MA 1160 or MA 1161

**MA 2720 - Statistical Methods** Introduction to the design and analysis of statistical studies. Topics include methods of data collection, descriptive and graphical methods, probability, statistical inference on means, regression and correlation, and single variable ANOVA. Not open to students with credit in MA3710. **Credits:** 4.0 **Lec-Rec-Lab:** (0-4-0) **Semesters Offered:** Fall, Spring, Summer **Restrictions:** May not be enrolled in one of the following Major(s): Mathematics **Pre-Requisite(s):** MA 1020 or MA 1030

or  
**MA 3710 - Engineering Statistics** Introduction to the design, conduct, and analysis of statistical studies aimed at solving engineering problems. Topics include methods of data collection, descriptive and graphical methods, probability and probability models, statistical inference, control charts, design of experiments. Not open to students with credit in MA2720. **Credits:** 3.0 **Lec-Rec-Lab:** (0-3-0) **Semesters Offered:** Fall, Spring, Summer **Pre-Requisite(s):** MA 2160

## Science

**PH 1100 - Physics by Inquiry I** Experiments covering kinematics, force, conservation of momentum, conservation of energy, and waves are explored through guided construction. The course emphasizes understanding physical concepts through inquiry and the scientific method **Credits:** 1.0 **Lec-Rec-Lab:** (0-0-2) **Semesters Offered:** Fall, Spring, Summer **Pre-Requisite(s):** MA 1160(C) or MA 1161(C)

**PH 2100 - University Physics I-Mechanics** A calculus-based introduction to classical mechanics. Topics include kinematics, Newton's laws, impulse and momentum, work and energy, and the universal law of gravitation. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Fall, Spring, Summer **Pre-Requisite(s):** PH 1100(C) and (MA 1160 or MA 1161 or MA 1135) and MA 2160(C)

**CH 1150 - University Chemistry I** Introduces the foundations of chemistry, including electronic structure of atoms and molecules, intermolecular forces, states of matter, chemical reactions, organic chemistry, chemical equilibria, kinetics, and acid-base chemistry. Includes laboratory component that emphasizes lecture components. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Fall, Spring, Summer **Co-Requisite(s):** CH 1151

**CH 1151 - University Chemistry Lab I** Laboratory to accompany CH1150. **Credits:** 1.0 **Lec-Rec-Lab:** (0-0-3) **Semesters Offered:** Fall, Spring, Summer **Co-Requisite(s):** CH 1150

## Business Core

**ACC 2000 - Accounting Principles I** Introduction to basic principles, concepts, and theoretical framework of financial accounting with the emphasis on its use by economically rational decision makers. Topics include the decision-making environment and the accounting cycles, processes, and statements. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Fall, Spring, Summer

**ACC 2100 - Accounting Principles II** Emphasizes the role of accounting information within a firm. Topics include budgeting, responsibility accounting, cost allocations, cost behavior, decision models, capital budgeting, and an introduction to product costing in manufacturing and service sector firms. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Fall, Spring, Summer **Pre-Requisite(s):** ACC 2000 or BA 2300 or BA 2330

**FIN 3000 - Principles of Finance** Introduction to the principles of finance. Topics include financial mathematics, the capital investment decision, financial assets valuation, and the risk-return relationship **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Fall, Spring, Summer **Pre-Requisite(s):** (MA 2710 or MA 2720 or MA 3710 or BUS 2100 or BA 2100) and (ACC 2100(C) or BA 2310 or BA 2340)

**MKT 3000 - Principles of Marketing** Emphasizes decisions made in developing both strategic and tactical marketing plans. Uses computer simulations, experiential learning assignments, and marketing plan development to demonstrate principles of market segmentation, product development, pricing, distribution planning, and promotion. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Fall, Spring, Summer **Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**MGT 3000 - Organizational Behavior** Covers concepts of human relations and organizational behavior through the study of people's behavior at work. Develop understanding, attitudes, and skills leading to increased personal effectiveness. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Fall, Spring, Summer **Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**MIS 2000 - IS/IT Management** Focuses on the theory and application of the information-systems discipline within an organizational context, and identifies the roles of management, users, and information systems professionals. Covers the use of information systems and implications for decision support to improve business processes, and addresses the ethical, legal, and social issues of IT. **Credits:** 3.0 **Lec-Rec-Lab:** (0-3-0) **Semesters Offered:** Fall, Spring, Summer **Restrictions:** May not be enrolled in one of the following Class(es): Freshman **Pre-Requisite(s):** BUS 1100 or BA 1100 or CS 1121 or CS 1131 or ENG 1101 or (ENG 1001 and ENG 1100) or SAT 1200

**BUS 2200 - Business Law** Provides an understanding of the legal basis of contracts and their enforcement in the areas of general contracts, contracts of commercial sales and of agency, and commercial paper. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Fall, Spring, Summer **Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**OSM 3000 - Operations and Supply Chain Management** Fundamental principles of operations and supply chain management; includes strategic importance and relevant interrelated concepts and tools in product/process design, work systems, forecasting, inventory and materials management, just-in-time, scheduling, and capacity management. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Fall, Spring, Summer **Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore **Pre-Requisite(s):** MA 2710 or MA 2720 or MA 3710 or EET 2010 or BUS 2100 or BA 2100

**MGT 4000 - Strategic Management** Introduces strategy content (e.g., differentiation, diversification, and strategic alliances) and strategizing processes (e.g., decision-making and restructuring). The course emphasizes strategies and strategizing processes within technological firms. **Credits:** 3.0 **Lec-Rec-Lab:** (0-3-0) **Semesters Offered:** Fall, Spring **Restrictions:** Must be enrolled in one of the following College(s): School of Business & Economics; Must be enrolled in one of the following Class(es): Senior **Pre-Requisite(s):** (BA 3200 or MIS 2000) and (BA 3400 or FIN 3000) and (BA 3610 or OSM 3000) and (BA 3700 or MGT 3000) and (BA 3800 or MKT 3000)

**MGT 4600 - Management of Technology and Innovation** Uses an evolutionary process perspective that examines how technology strategy evolves from underlying technology competences and capabilities, patterns of technological innovations, development of technological capabilities and competences, the role of collaboration in innovation, and profiting

from new technologies. **Credits: 3.0 Lec-Rec-Lab: (0-3-0) Semesters Offered:** Fall, Spring **Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**BUS 4991 - Business Development I** Focuses on the development of a business plan including marketing plans, organization, distribution, and financial projections. Emphasis is on the senior design project or enterprise project assigned to the student. **Credits: 3.0 Lec-Rec-Lab: (0-3-0) Semesters Offered:** Fall **Pre-Requisite(s):** (BA 1100 or BUS 1100) and (BA 2110 or BUS 2300) and (BA 2300 or BA 2330 or ACC 2000) and (BA 2310 or BA 2340 or ACC 2100) and (BA 2500 or BUS 2200) and (BA 2700 or MGT 2000) and (BA 3200 or MIS 2000) and (BA 3400 or FIN 3000) and (BA 3610 or OSM 3000) and (BA 3700 or MGT 3000) and (BA 3800 or MKT 3000)

**BUS 4992 - Business Development II** Completion and presentation of the business plan for the senior design project or enterprise project assigned to the student. **Credits: 3.0 Lec-Rec-Lab: (0-3-0) Semesters Offered:** Spring **Pre-Requisite(s):** BA 4991

## Business Electives

### Choose one:

**ACC 3500 - Managerial/Cost Accounting I** The primary emphasis is on traditional and contemporary product costing techniques, cost allocation practices, and basic cost-management issues. Topics include process costing, standard costing, activity-based costing, backflush costing, cost allocation issues, balanced scorecard, strategic profitability analysis, and the role of accounting in contemporary management practices. **Credits: 3.0 Lec-Rec-Lab: (0-3-0) Semesters Offered:** Fall **Pre-Requisite(s):** ACC 2100 or BA 2310 or BA 2340

**EC 3100 - International Economics** Introduction to international economics, including balance of payments, accounting, foreign exchange markets, international trade theory, barriers to trade, trade and development, regional economic integration, and current U.S. international economic issues. **Credits: 3.0 Lec-Rec-Lab: (3-0-0) Semesters Offered:** Fall, Spring, Summer **Pre-Requisite(s):** EC 2001

**FIN 4000 - Investment Analysis** Overview of financial products. Operations of the stock market, bond market, and other financial markets. Focus on portfolio theory and basic stock and bond valuation techniques. **Credits: 3.0 Lec-Rec-Lab: (0-3-0) Semesters Offered:** Spring **Pre-Requisite(s):** BA 3400 or EC 3400 or FIN 3000

**FIN 4100 - Advanced Financial Management** Advanced topics in managerial finance: Advanced capital budgeting, project analysis, capital acquisition, capital structure and dividend policy, and other topics. **Credits: 3.0 Lec-Rec-Lab: (0-3-0) Semesters Offered:** Fall **Pre-Requisite(s):** BA 3400 or EC 3400 or FIN 3000

**FIN 4200 - Derivatives and Financial Engineering** Covers the pricing and use of options, financial futures, swaps, and other derivative securities. **Credits: 3.0 Lec-Rec-Lab: (0-3-0) Semesters Offered:** Fall **Pre-Requisite(s):** BA 3400 or EC 3400 or FIN 3000

**FIN 4500 - Financial Risk Management and Financial Engineering** Detailed analysis of the measurement of financial risk and the tools and techniques available to manage financial risk. Topics include financial disasters, risk measurement (market, default, currency exchange, value-at-risk) and the hedging of these risks. **Credits: 3.0 Lec-Rec-Lab: (0-3-0) Semesters Offered:** Fall **Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore **Pre-Requisite(s):** FIN 3000 or BA 3400 or EC 3400

**FIN 4700 - Global Finance** Studies international financial systems and markets. Covers the principle of comparative advantage, balance of payments, exchange rate systems, theories of international finance, identification of international risk exposures, the management and treatment of risk, and special topics of international finance. **Credits: 3.0 Lec-Rec-Lab: (0-3-0) Semesters Offered:** Fall **Pre-Requisite(s):** BA 3400 or EC 3400 or FIN 3000

### Choose one:

**MKT 3600 - Marketing Research** Focuses on the application of the marketing research in marketing decision-making. Topics include survey methodology, research design, statistical analysis of data, and report writing. **Credits: 3.0 Lec-Rec-Lab: (0-3-0) Semesters Offered:** Spring **Pre-Requisite(s):** (MA 2710 or MA 2720 or MA 3710 or BUS 2100 or BA 2100) and (BA 3800 or MKT 3000)

**MKT 4000 - New Products Marketing** Explores strategic aspects of new product management. Topics include the process of new product development, product life-cycle management, brand management, and product commercialization strategy. **Credits: 3.0 Lec-Rec-Lab: (0-3-0) Semesters Offered:** Spring **Pre-Requisite(s):** MKT 3000 or BA 3800

**MKT 4100 - Sales and Sales Management** Looks at the role of the selling function as an integral part of the total marketing effort. Examines the administrative functions of sales management, the dynamics of the buying-selling process, and sales strategies and tactics. **Credits: 3.0 Lec-Rec-Lab: (0-3-0) Semesters Offered:** Fall, Spring **Pre-Requisite(s):** BA 3800 or MKT 3000

**MKT 4300 - Global Marketing** Discusses the critical elements of international marketing strategy: socio-political-economic environment, global consumer culture, entry strategy, and global marketing mix. Utilizes cases and examples in order for students to better understand the globalized marketplace. **Credits: 3.0 Lec-Rec-Lab: (0-3-0) Semesters Offered:** Fall **Pre-Requisite(s):** MKT 3000 or BA 3800

### Choose one:

**OSM 3200 - Project Management** Focuses on application of systems analysis to project definition and selection. Covers project teams, their structures, and interactions; cross-functional communication in technological project management; project management planning, scheduling, and control tools; project monitoring, evaluation, and termination; multiple project management and inter-project relations. **Credits: 3.0 Lec-Rec-Lab: (3-0-0) Semesters Offered:** Fall, Spring, Summer **Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore **Pre-Requisite(s):** MA 2710 or MA 2720 or MA 3710 or EET 2010 or BUS 2100 or BA 2100

**OSM 4300 - Project Planning and Management for Engineers** The various stages in a project life cycle will be defined and explored such as planning, metrics, execution, completion, and maintenance. Basic tools such as CPM, PERT, Gantt, and budgeting will be introduced. Change assimilation in the context of project management will also be discussed. Not open to students with credit in OSM 3200 or BA3620. **Credits: 3.0 Lec-Rec-Lab: (3-0-0) Semesters Offered:** Fall **Pre-Requisite(s):** BUS 2100 or BA 2100 or MA 2720 or MA 3710

## Engineering Core

**ENG 1101 - Engineering Analysis and Problem Solving** An introduction to the engineering profession and to its various disciplines. Focuses on developing problem-solving skills, computational skills, and communication skills. Through active, collaborative work, students work on teams to apply the engineering problem-solving method to "real-world" problems. **Credits: 3.0 Lec-Rec-Lab: (0-0-5) Semesters Offered:** Fall, Spring, Summer **Pre-Requisite(s):** (MA 1160(C) or MA 1161(C)) and (Spatial Visualization Score  $\geq$  19 or ENG 1002(C))

**ENG 1102 - Engineering Modeling and Design** Continuation of ENG1101. Introduction to the engineering design process with an emphasis on graphics and documentation. Focuses on engineering problem solving in the context of the design process. **Credits: 3.0 Lec-Rec-Lab: (0-0-5) Semesters Offered:** Fall, Spring, Summer **Pre-Requisite(s):** (MA 1160 or MA 1161) and (ENG 1101 or (ENG 1001 and ENG 1100) and (Spatial Visualization Score  $\geq$  19 or ENG 1002))

### Pick three of the following:

**ENG 2120 - Statics-Strength of Materials** The composition and resolution of forces and force systems, principles of equilibrium applied to various bodies, simple structures, friction, and 2nd moments of area. Intro to the mechanical behavior of materials, including calculation of stresses, strains, and deformations due to axial, torsional, and flexural loading. **Credits: 4.0 Lec-Rec-Lab: (0-4-0) Semesters Offered:** Spring **Restrictions:** May not be enrolled in one of the following Major(s): Mechanical Engineering, Civil Engineering **Pre-Requisite(s):** MA 2160 and PH 2100 and ENG 1102

**ENG 3200 - Thermodynamics/Fluid Mechanics** Provides engineering students with a unified understanding of the fundamental conservation laws and property accounting applied to thermodynamic and fluid dynamic systems. Topics will include but are not limited to: ideal gas behavior; heat, work, and energy; 1st and 2nd laws of thermodynamics; heat pumps; cycles; hydrostatics; Bernoulli; pipe flow and loss; and lift and drag. **Credits: 4.0 Lec-Rec-Lab: (0-4-0) Semesters Offered:** Fall, Spring **Pre-Requisite(s):** MA 2160 and CH 1112 or (CH 1150 and CH 1151) and PH 2100 and ENG 1102

**EE 3010 - Circuits and Instrumentation** Designed for nonmajors. Covers the principles of electrical and electronic measurements, including dc, ac, semiconductor devices, amplifiers, and filtering. **Credits:** 3.0 **Lec-Rec-Lab:** (2-0-2) **Semesters Offered:** Fall, Spring, Summer **Restrictions:** May not be enrolled in one of the following Major(s): Electrical Engineering, Computer Engineering

**MY 2100 - Introduction to Materials Science and Engineering** Introduction to the structure, processing, properties, and performance of engineering materials, including metals, polymers, glasses, ceramics, and composites. Presents case studies covering selection of materials, component design, and analysis of component failures. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Fall, Spring, Summer **Pre-Requisite(s):** CH 1112 or CH 1122 or (CH 1150 and CH 1151) or (CH 1160 and CH 1161)

## Engineering Electives (choose one area of study)

### General

ENG 2120 or ENG 3200 or EE3010 or MY 2100 (see above)

**MEEM 2500 - Integrated Design and Manufacturing** Focuses on practical aspects of design and manufacturing. Covers fundamentals of manufacturing processes and includes weekly lab providing hands-on experiences with manufacturing issues that influence component design. Incorporates computer-aided manufacturing tools. **Credits:** 4.0 **Lec-Rec-Lab:** (0-3-3) **Semesters Offered:** Fall, Spring **Restrictions:** Must be enrolled in one of the following Major(s): Engineering, Mechanical Engineering Tech, Engineering-Manufacturing, Mechanical Engineering, Industrial Technology, Biomedical Engineering, Engineering-Mechanical Design **Pre-Requisite(s):** (ENG 1102 or TE 1020) and (MY 2100(C) or MET 1540(C))

**MY 4800 - Material and Process Selection in Design** The principles of materials selection for engineering design. Topics include selection based on strength, stiffness, thermal properties, high temperature behavior, corrosion resistance, formability, joinability, manufacturability, recyclability, etc. Considers ethics and economics. Presents numerous case studies and examples. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Spring **Pre-Requisite(s):** MY 2100

### Biomedical Engineering

ENG 2120 or ENG 3200 or EE3010 or MY 2100 (see above)

**BE 2400 - Biology for Engineers I** General principles and engineering applications of science and biology, including cell biology, physiology, molecular biology, genetics, and biotechnology. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Spring **Restrictions:** May not be enrolled in one of the following Class(es): Senior **Pre-Requisite(s):** CH 1150 and ENG 1102 and MA 2160 and PH 2100 and UN 1001

**BE 2600 - Introduction to Biomedical Engineering** Covers basis concepts of Biomedical Engineering including statistical distributions, physiological modeling, medical imaging, biomechanics, biomaterials, and biomedical instrumentation. It serves as the starting point for more advanced courses in biomedical engineering and to give students a broad yet quantitative overview of the field. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Fall **Restrictions:** Must be enrolled in one of the following Class(es): Sophomore, Junior **Pre-Requisite(s):** CH 1150 and ENG 1102 and MA 2160 and PH 2100 and UN 1001

**BE 3500 - Biomedical Materials** An overview of biomaterials in three basic classes: metals, ceramics, and polymers. Topics include biomaterials used in special medical applications (such as tissue replacement, absorbable and non-absorbable sutures, and soft tissue replacements) as well as discussion of tissue, body, and blood response to implants (bio-compatibility). **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Fall **Pre-Requisite(s):** (BE 2400 or BL 2400) and MY 2100 and (MEEM 2150(C) or ENG 2120(C)) and BE 2600

### Civil Engineering

**CE 3101 - Civil Engineering Materials** Covers properties and behavior of typical civil engineering materials, including wood, metals, aggregates, asphalt cement concrete, portland cement concrete, and composites. Laboratory exercises demonstrate selected engineering mechanics principles, including elastic, inelastic, and time-dependent material behavior. Additional topics include testing techniques, materials standards, report writing, and presentation of experimental data. **Credits:** 3.0 **Lec-Rec-Lab:** (0-2-3) **Semesters Offered:** Fall, Spring **Pre-Requisite(s):** ENG 2120 or MEEM 2150

**CE 3202 - Structural Analysis** Introduction to structural concepts and techniques for analyzing trusses, determinate and indeterminate beams, and frame structures. Apply concepts from statics and mechanics of materials to determine internal forces and deflections of structural members and systems, including loads and load paths. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Fall, Spring **Pre-Requisite(s):** ENG 2120 or MEEM 2150

**CE 3332 - Fundamentals of Construction Engineering** Introduction to concepts required by professionals involved in the construction industry. Includes contracts, bidding, estimating, scheduling, cash flow, safety, labor issues, equipment ownership, and productivity. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Fall, Spring, Summer **Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**CE 3401 - Transportation Engineering** Introduction to transportation in the United States, highway types and systems, principles of route location, vehicle characteristics, highway geometrics and design standards, drainage, environmental considerations, pavement design, and economic principles and engineering criteria for highway improvements. **Credits:** 3.0 **Lec-Rec-Lab:** (0-3-0) **Semesters Offered:** Fall, Spring, Summer **Restrictions:** May not be enrolled in one of the following Class(es): Freshman

### Electrical Engineering

**EE 2174 - Digital Logic and Lab** Introduces analysis, design, and application of digital logic. Includes Boolean algebra, binary numbers, logic gates, combinational and sequential logic, storage elements and hardware-description-language based synthesis. **Credits:** 4.0 **Lec-Rec-Lab:** (3-0-2) **Semesters Offered:** Fall, Spring, Summer **Pre-Requisite(s):** EET 2241(C) or CS 1121(C) [Note: Added to the Binder in Fall 2011]

**EE 3120 - Electric Energy Systems** An overview of the generation and utilization of electrical energy. Covers three-phase circuits, transformers, photovoltaics, batteries, electromechanical energy conversion, and an overview of electric power systems, including economic issues. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Fall, Spring, Summer **Pre-Requisite(s):** EE 2110 or EE 3010

**EE 3171 - Microcomputer Applications and Lab** **Credits:** 4.0 **Semesters Offered:** Fall, Spring, Summer **Pre-Requisite(s):** EE 2174 [Note: Will be added to the Binder in Fall 2012]

### Energy Engineering

**PH 2200 - University Physics II-Electricity and Magnetism** A calculus-based introduction to electromagnetism. Topics include Coulomb's law, electric fields, Gauss's law, electric potential, capacitance, circuits, magnetic forces and fields, Ampere's law, induction, Maxwell's equations, and electromagnetic waves. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Fall, Spring, Summer **Pre-Requisite(s):** (PH 1200(C) or PH 2261(C)) and (PH 2100 or PH 1160) and MA 2160

**MEEM 4200 - Principles of Energy Conversion** Introduces basic background, terminology, and fundamentals of energy conversion. Discusses current and emerging technologies for production of thermal, mechanical, and electrical energy. Topics include fossil and nuclear fuels, solar energy, wind turbines, fuel and solar cells. **Credits:** 3.0 **Lec-Rec-Lab:** (0-3-0) **Semesters Offered:** Fall - Offered alternate years beginning with the 2005-2006 academic year **Pre-Requisite(s):** MEEM 3230(C) or CM 3230 or ENG 3200 or MY 3100

**CM 3974 - Fuel Cell Fundamentals** This course provides an introduction to fuel cells and fuel cell systems. Topics include an overview of fuel-cell construction, fuel-cell chemistry, fuel-cell losses and efficiency, and integrating fuel cells into vehicles. **Credits:** 1.0 **Lec-Rec-Lab:** (1-0-0) **Semesters Offered:** Fall, Spring **Pre-Requisite(s):** CH 1112 or (CH 1150 and CH 1151)

**CM 3977 - Fundamentals of Hydrogen as an Energy Carrier** This course provides an overview of traditional and alternative energy sources, with particular emphasis on hydrogen energy. Discussion of energy production and sources; electric and hydrogen vehicles; production, distribution, and policy of hydrogen, and

the hydrogen economy. **Credits:** 1.0 **Lec-Rec-Lab:** (1-0-0) **Semesters Offered:** Fall **Restrictions:** May not be enrolled in one of the following Class(es): Freshman **Pre-Requisite(s):** CH 1112 or (CH 1150 and CH 1151) and PH 2200

**CM 3978 - Hydrogen Measurements Lab** This course provides an introduction to basic experiments and measurements that relate to hydrogen and hydrogen powered fuel cells. Includes chemical and electrical safety, fuel cell operation and introduction to fuel cell integration into practical applications. **Credits:** 1.0 **Lec-Rec-Lab:** (0-0-2) **Semesters Offered:** Spring **Restrictions:** May not be enrolled in one of the following Class(es): Freshman **Pre-Requisite(s):** (CH 1150 and CH 1151) and PH 2200

## Environmental Engineering

**ENVE 3503 - Environmental Engineering** Application of fundamental chemical, biological, and physical principles of environmental engineering to design and operation of systems used for water and wastewater treatment, solid waste management, air pollution control, and analysis of quality of surface water, air, and groundwater. **Credits:** 3.0 **Lec-Rec-Lab:** (0-3-0) **Semesters Offered:** Fall, Spring, Summer **Pre-Requisite(s):** MA 2160 and CH 1112 or (CH 1150 and CH 1151)

**ENVE 4505 - Surface Water Quality Engineering** Develops the scientific basis for water quality management in lakes and rivers. Considers the origin, behavior, and fate of nutrients and toxic substances. Introduces engineered approaches for lake management, including mass balance modeling. Presents techniques for water quality restoration and the legal framework supporting pollution control. **Credits:** 3.0 **Lec-Rec-Lab:** (0-2-3) **Semesters Offered:** Fall **Pre-Requisite(s):** ENVE 3501 or ENVE 3503 Undergraduate Course Descriptions, 2011-12, Page 37 of 95

**ENVE 4506 - Application of Sustainability Principles & Environmental Regulations to Engineering Practice** Study of sustainability, federal and state regulations and policies that govern solid and hazardous waste management, environmental risk of toxic chemicals, life cycle assessment, and green engineering. **Credits:** 3.0 **Lec-Rec-Lab:** (0-3-0) **Semesters Offered:** Spring **Pre-Requisite(s):** ENVE 3501 or ENVE 3503

**ENVE 4508 - Water and Wastewater Treatment** Principles of physical, chemical and biological processes employed in water and wastewater treatment. Design of selected individual units within water and wastewater treatment systems. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Fall **Pre-Requisite(s):** (ENVE 3501 or ENVE 3503) and (ENG 3200 or ENG 3507)

## Geological Engineering

**GE 2000 - Understanding the Earth** Introduction to materials and processes that shape the earth we live on. Lecture and laboratories acquaint students with minerals, rocks, earth resources, weathering, geologic time, landslides, groundwater, streams, shorelines, deserts, glaciers, geologic structures, earthquakes, plate tectonics, and the dynamics of the earth's crust, mantle, and core. **Credits:** 3.0 **Lec-Rec-Lab:** (2-0-3) **Semesters Offered:** Fall, Spring, Summer

**GE 3850 - Geohydrology** Geologic and hydrologic factors controlling the occurrence, movement, and development of subsurface water. Quantitative methods for analyzing groundwater systems are introduced. **Credits:** 3.0 **Lec-Rec-Lab:** (2-0-3) **Semesters Offered:** Fall

**CE 3810 - Soil Mechanics for Engineers** Develops the terminology and descriptions common to the field. Studies soil compressibility, fluid flow, response to mechanical compaction, and strength as well as methods of determining geostatic stresses and stress changes due to boundary loadings. An experimental laboratory experience reinforces the lecture material. **Credits:** 4.0 **Lec-Rec-Lab:** (3-0-3) **Semesters Offered:** Fall, Spring, Summer **Pre-Requisite(s):** (GE 2000 or GE 2100) and (MEEM 2150 or ENG 2120) and (ENG 3200 or ENG 3507)

One from the following:

**GE 4610 - Formation Evaluation and Petroleum Engineering** Principles and practice of formation evaluation, primarily through analysis of well logs and the principles and practice of petroleum engineering. Emphasizes reservoir engineering and simulation. Students conduct projects using actual field data. A three-day field trip is required. **Credits:** 3.0 **Lec-Rec-Lab:** (2-1-0) **Semesters Offered:** Fall

**GE 4800 - Groundwater Engineering** Application of geohydrology principles to design water-well supplies, site investigations, and subsurface remediation systems. **Credits:** 3.0 **Lec-Rec-Lab:** (0-2-3) **Semesters Offered:** On Demand **Pre-Requisite(s):** GE 3850

**GE 4860 - Computer Methods in Geomechanics** Computer methods for the design problems encountered in geomechanics. Applications to be selected from slope stability, earth retention systems, and seepage. Students will be introduced to limit equilibrium and finite element analysis through theory and computational labs. **Credits:** 3.0 **Lec-Rec-Lab:** (2-0-3) **Semesters Offered:** Fall **Pre-Requisite(s):** CE 3810

## Material Science and Engineering

**MY 4300 - Mechanical Behavior of Materials** An introduction to the deformation and fracture behavior of materials. Topics include multiaxial stress and strain, elastic and plastic deformation, hardening mechanisms, viscoelasticity, fracture, fatigue, creep, and microstructure/property relationships. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Fall **Pre-Requisite(s):** MY 2100 and (MEEM 2150 or ENG 2120)

**MY 4800 - Material and Process Selection in Design** The principles of materials selection for engineering design. Topics include selection based on strength, stiffness, thermal properties, high temperature behavior, corrosion resistance, formability, joinability, manufacturability, recyclability, etc. Considers ethics and economics. Presents numerous case studies and examples. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Spring **Pre-Requisite(s):** MY 2100

Two from the following:

**MY 4190 - Environmental Engineering for Materials Processing Industries** Assessment and analysis of environmental impacts from materials processing industries. Regulations, permits, and industrial practices for monitoring and solving air, water, and solid environmental issues. Pollution prevention. Life cycle analysis. Material flow analysis. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Fall **Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**MY 4600 - Introduction to Polymer Engineering** Basics in polymer science including molecular characteristics, synthesis, structure and properties of polymers. Various processing techniques and mechanical/ structural applications of polymers. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Fall **Pre-Requisite(s):** MY 2100

**MY 4130 - Principles of Metal Casting** Principles of metal casting, including melting practice, casting design, mold design, heat transfer and solidification, fluid flow and gating design. Introduction to computer simulation techniques for mold filling, solidification, and development of residual stress. Structure-property relations in cast metals. Recycling and environmental issues of the cast metals industry. **Credits:** 3.0 **Lec-Rec-Lab:** (2-0-3) **Semesters Offered:** Fall **Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore **Pre-Requisite(s):** MY 2100

**MY 4155 - Composite Materials** Mechanistic aspects of property development in metal, ceramic, and polymeric composites. The role of composite architecture, processing, and microstructure on properties. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Spring **Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore **Pre-Requisite(s):** MY 2100

## Mechanical Engineering

**MEEM 2500 - Integrated Design and Manufacturing** Focuses on practical aspects of design and manufacturing. Covers fundamentals of manufacturing processes and includes weekly lab providing hands-on experiences with manufacturing issues that influence component design. Incorporates computer-aided manufacturing tools. **Credits:** 4.0 **Lec-Rec-Lab:** (0-3-3) **Semesters Offered:** Fall, Spring **Restrictions:** Must be enrolled in one of the following Major(s): Engineering, Mechanical Engineering Tech, Engineering-Manufacturing, Mechanical Engineering, Industrial Technology, Biomedical Engineering, Engineering-Mechanical Design **Pre-Requisite(s):** (ENG 1102 or TE 1020) and (MY 2100(C) or MET 1540(C))

**MEEM 4150 - Intermediate Mechanics of Materials** Basic concepts of three-dimensional stress and strain. Inelastic behavior of axial members, circular shafts and symmetric beams. Deflections of indeterminate beams. Unsymmetrical bending, shear flow and shear center for open sections. Energy methods for structures made up of one-dimensional elements. Introduction to theories of failures for anisotropic materials. **Credits:** 3.0 **Lec-Rec-Lab:** (0-3-0) **Semesters Offered:** Fall **Pre-Requisite(s):** MEEM 2150 [Note: This prerequisite will be changed to MEEM 2150 or ENG 2120 in the Fall 2012 Binder.]

**MEEM 4200 - Principles of Energy Conversion** Introduces basic background, terminology, and fundamentals of energy conversion. Discusses current and emerging technologies for production of thermal, mechanical, and electrical energy. Topics include fossil and nuclear fuels, solar energy, wind turbines, fuel and solar cells. **Credits:** 3.0 **Lec-Rec-Lab:** (0-3-0) **Semesters Offered:** Fall - Offered alternate years beginning with the 2005-2006 academic year **Pre-Requisite(s):** MEEM 3230(C) or CM 3230 or ENG 3200 or MY 3100

## Mining Engineering

**GE 2000 - Understanding the Earth** Introduction to materials and processes that shape the earth we live on. Lecture and laboratories acquaint students with minerals, rocks, earth resources, weathering, geologic time, landslides, groundwater, streams, shorelines, deserts, glaciers, geologic structures, earthquakes, plate tectonics, and the dynamics of the earth's crust, mantle, and core. **Credits:** 3.0 **Lec-Rec-Lab:** (2-0-3) **Semesters Offered:** Fall, Spring, Summer

**GE 2020 - Introduction to Mining Engineering and Mining Methods** Learn how various mining components, from prospecting to financing to reclamation, fit together. Includes advantages and drawbacks of different mining methods and their selection. Introduces ethics and professional development. Use of basic computer and mine design software. **Credits:** 4.0 **Lec-Rec-Lab:** (4-0-0) **Semesters Offered:** Fall, Spring - Offered alternate years beginning with the 2005-2006 academic year

**GE 3400 - Drilling and Blasting** Rock penetration and fragmentation methods to include boring, cutting, drilling, and blasting techniques. Design of surface and underground blasting rounds. Formulation of design criteria to minimize the adverse effects of blasting. Field demonstration in the design, monitoring, and evaluation of blasts. **Credits:** 3.0 **Lec-Rec-Lab:** (2-0-2) **Semesters Offered:** Fall, Spring - Offered alternate years beginning with the 2006-2007 academic year **Pre-Requisite(s):** GE 2020 and PH 2100

**GE 4360 - Materials Handling** Surface and underground materials handling methods. Selection and performance analysis of materials handling equipment. Computer applications. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** On Demand **Pre-Requisite(s):** PH 2100

## Mechanical Engineering

**GE 2000 - Understanding the Earth** Introduction to materials and processes that shape the earth we live on. Lecture and laboratories acquaint students with minerals, rocks, earth resources, weathering, geologic time, landslides, groundwater, streams, shorelines, deserts, glaciers, geologic structures, earthquakes, plate tectonics, and the dynamics of the earth's crust, mantle, and core. **Credits:** 3.0 **Lec-Rec-Lab:** (2-0-3) **Semesters Offered:** Fall, Spring, Summer

**GE 3050 - Structural Geology** Rock structures and regional settings resulting from the application of deforming forces, including the geometry, origin, and mechanics of folds, foliations, lineations, faults and joints, and structures in orogenic belts. **Credits:** 4.0 **Lec-Rec-Lab:** (3-0-2) **Semesters Offered:** Spring **Pre-Requisite(s):** GE 2000

**GE 3200 - Geochemistry** Introduction to elements of modern geochemistry including aqueous solutions, isotopes, age dating, etc. Emphasizes concepts and quantitative methods. Teaches principles of thermodynamics and phase equilibria from an introductory perspective as they pertain to geologic systems. **Credits:** 3.0 **Lec-Rec-Lab:** (2-1-0) **Semesters Offered:** Fall **Pre-Requisite(s):** (CH 1150 and CH 1151)

**GE 4610 - Formation Evaluation and Petroleum Engineering** Principles and practice of formation evaluation, primarily through analysis of well logs and the principles and practice of petroleum engineering. Emphasizes reservoir engineering and simulation. Students conduct projects using actual field data. A three-day field trip is required. **Credits:** 3.0 **Lec-Rec-Lab:** (2-1-0) **Semesters Offered:** Fall

## Transportation Engineering

**CE 3401 - Transportation Engineering** Introduction to transportation in the United States, highway types and systems, principles of route location, vehicle characteristics, highway geometrics and design standards, drainage, environmental considerations, pavement design, and economic principles and engineering criteria for highway improvements. **Credits:** 3.0 **Lec-Rec-Lab:** (0-3-0) **Semesters Offered:** Fall, Spring, Summer **Restrictions:** May not be enrolled in one of the following Class(es): Freshman

**CE 4402 - Traffic Engineering** Introduction to traffic engineering, traffic characteristics, data collection techniques, capacity analysis, traffic control devices, intersection control, traffic signal systems, parking, and street operations. **Credits:** 3.0 **Lec-Rec-Lab:** (0-3-0) **Semesters Offered:** Fall, Summer **Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**CE 4404 - Railroad Engineering** Overview of basic elements and roles of rail transportation, history, organizations and economics, safety, intercity and urban passenger rail, freight operations, track-train dynamics, signals and communications, motive power and equipment, track components, construction and maintenance. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Fall **Restrictions:** May not be enrolled in one of the following Class(es): Freshman, Sophomore

**CE 4406 - Airport Planning and Design** Introduction to the air transportation system, airport planning studies, demand forecasting, aircraft characteristics, runway requirements, airport layout and design. Also includes environmental impacts, airport capacity and operations, terminal and ground access planning and analysis. **Credits:** 3.0 **Lec-Rec-Lab:** (0-3-0) **Semesters Offered:** Fall, Spring

## General Education and HASS

**UN 1001 - Perspectives on Inquiry** Writing-intensive course which engages students in college level inquiry. Students develop fundamental intellectual habits, understand how to integrate various perspectives on knowledge, and begin to learn how to meet the changing needs of a global, technological, diverse, and environmentally sensitive society. **Credits:** 3.0 **Lec-Rec-Lab:** (0-3-0) **Semesters Offered:** Fall, Spring, Summer **Restrictions:** Must be enrolled in one of the following Class(es): Freshman

**UN 1002 - World Cultures** Examines diversity and change around the globe from perspectives of social sciences, humanities, and arts; explores human experience from prehistory to present. Classroom lectures accompanied by films, live performances, and guest speakers. One complete year of a single foreign language plus World Cultures (UN1003, 1-credit-activities) substitutes for World Cultures. **Credits:** 4.0 **Lec-Rec-Lab:** (3-0-3) **Semesters Offered:** Fall, Spring, Summer **Restrictions:** Must be enrolled in one of the following Class(es): Freshman

**UN 2001 - Composition: Oral, Written, and Visual** Provides advanced, direct instruction in composition. Students examine and interpret communication practices and apply what they learn to their own written, spoken, and visual work. Class projects ask students to communicate in a variety of modes and to attend to audience, purpose and context. **Credits:** 3.0 **Lec-Rec-Lab:** (0-3-0) **Semesters Offered:** Fall, Spring, Summer **Restrictions:** Must be enrolled in one of the following Class(es): Freshman, Sophomore **Pre-Requisite(s):** UN 1001 and (UN 1002 or UN 1003)

**UN 2002 - Institutions** From families to governments, to markets, to our interactions with the natural environment, institutions organize collective human action. Introduces students to the nature and role of institutions in shaping today's world. Specific topics will vary by section, but all sections address a set of core questions and concepts. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Fall, Spring, Summer **Restrictions:** Must be enrolled in one of the following Class(es): Sophomore

**EC 2001 - Principles of Economics** An introduction to economics. The microeconomics portion covers consumer choice, the firm, value and price theory, and distribution theory. The macroeconomics portion covers national income analysis, fiscal policy, money and monetary policy, the commercial banking system, and the Federal Reserve System. **Credits:** 3.0 **Lec-Rec-Lab:** (3-0-0) **Semesters Offered:** Fall, Spring, Summer **Restrictions:** May not be enrolled in one of the following Class(es): Freshman **Pre-Requisite(s):** MA 1020 or MA 1031 or MA 1032 or MA 1135(C) or MA 1160(C) or MA 1161(C)

**Introduced to Senate: 01 February 2012**  
**Amended (in red) by Senate: 15 February 2012**  
**Approved by Senate: 15 February 2012**  
**Approved by Administration: 20 February 2012**  
**Approved by BOC: 23 February 2012**