New Undergraduate Course Approval Cover Form
Montana State University

This four-page form collects basic information about the proposed new course, provides information on the approval process, and includes all required approvals. Additional information (see INFO sheet) is also required as part of the New Course Packet.

Proposed New Course Information

Requested Rubric, Course Number, Core Designation (if needed):

Example: PHIL 361 RH

Course Title: Principles of Tribology
Abbreviated Course Title (≤30 chars): Tribology
First Semester to be Offered: Fall 2014

Submitted by:

Robert Amendola
x6296
roberta.amendola@me.montana.edu

Instructor: Roberta Amendola
Department: Mechanical and Industrial Engineering
College: College of Engineering

New Course Review Process

Instructor completes the New Course Packet, with Core Information if a Core designation is requested.

Instructor checks for "equivalent" course in the MUS system and recommends a common or unique course number.

Department Head’s signature indicates that course has been approved by the process used within the Department.

The Chair of the College Curriculum Committee signs to indicate College academic approval.

The College Dean signs to indicate that adequate resources are available to offer the course. Supporting information (Dean’s Statement) is typically required.

The New Course Packet (as PDF) is uploaded to the Provost’s Office server for distribution to other committees.

Course requests are sent to Curriculum and Program Committee (CPC). Core reviews are sent to appropriate Core subcommittee. Committees work in parallel when possible to speed approval process. Special topics courses (291,491) skip the CPC review (limited to two years.)

Provost’s Office reviews the new course request. New courses are submitted to MUS for Common Course Number (CCN) review. Dean and Department informed upon approval.

Approved new course sent to Registrar for inclusion in the Catalog and Schedule of Classes

Note: This diagram illustrates the typical flow path, but at any review step there can be a request for additional information or modifications. Careful review in early steps is the best way to speed the overall process. * Special topics courses (x91) require fewer signatures, but cannot be offered more than two times without committee review.

APPROVALS

Submitter *
Digitally signed by: Roberta Amendola
Date: 12/11/2013

Department Head *
Digitally signed by: Robert C. Rehr
Date: 12/11/2013

Chair, College Curriculum Comm.
Christine M. Foreman
Digitally signed by: Christine M. Foreman
Date: 12/10/2013

Dean *

Chair, Core Subcommittee (if app.)

Chair, CPC

Assoc. Provost *
INFORMATION NEEDED FOR COMMON COURSE NUMBERING

The process for identifying a common course number for a new course is as follows:

1. Course learning outcomes are prepared for the new course.
2. The person submitting the new course request looks at the CCN website to see if a course with similar outcomes already exists in the MUS system.

   www.mus.edu/Qtools/CCN/ccn_default.asp

   • If a course exists with at least 80% of the same outcomes, the course is considered “equivalent” to the proposed new course, and the new course should use the existing rubric and course number.
   • If no “equivalent” course is found, the person submitting the new course request should identify a unique course number that has not been used by any other course in the MUS system.

3. The requested rubric and course number are submitted as part of the new course packet.
4. The Provost’s Office submits the learning outcomes and the requested rubric and course number to the MUS to have a course number assigned to the course. (This will typically be the requested course number, but it could be changed.)
5. The assigned common course number is reported back to the person submitting the new course request.

<table>
<thead>
<tr>
<th>Requested Rubric, Course Number, Core Designation (if needed):</th>
<th>EMAT461</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Title:</td>
<td>Principles of Tribology</td>
</tr>
<tr>
<td>Abbrev. Course Title (≤ 30 char):</td>
<td>Tribology</td>
</tr>
<tr>
<td>Credits:</td>
<td></td>
</tr>
<tr>
<td>Department Offering Course:</td>
<td>Mechanical and Industrial Engineering</td>
</tr>
<tr>
<td>College:</td>
<td>College of Engineering</td>
</tr>
</tbody>
</table>

Is this course “equivalent” to a course in the MUS System?:

☐ Yes  ✔ No

Learning Outcomes for the Course:

Upon completion of this course students will be able to:

1) Describe surface topography, physico-chemical aspects of solid surfaces, and surface interactions.

2) Explain the mechanics of solid elastic and elastoplastic contacts.

3) Describe the various modes of wear: adhesive, delamination, fretting, abrasive, erosive, corrosive, oxidational (mild and severe) and melt.

4) Identify types of lubrication: boundary, solid-film, hydrodynamic, and hydrostatic lubrication.

5) Examine applications/case studies: sliding contacts, rolling contacts, bearing design, coating selection, and lubrication.

6) Explore the design of tribological surfaces and how to troubleshoot tribology problems.
INFORMATION REQUIRED BY THE REGISTRAR

The data needed to enter the new course into the MSU Catalog and Schedule of Classes is collected on this page. Once the new course has been approved, this page is automatically forwarded to the Registrar for data entry.

Assigned Rubric, Course Number, Core Designation (if needed): EMAT461
Course Title (for Catalog): Principles of Tribology
Course Title (for Schedule of Classes, 30 characters, max.):
First Semester to be Offered: Fall 2014
Restricted Entry/Consent of Instructor Required: ☑ Yes □ No
Instructor’s GID (last 4 digits only):
Department Offering Course: Mechanical and Industrial Engineering
College: College of Engineering

Is the requested course number available? (x4155 to check): ☑ Yes □ No
Frequency of course offering: ☑ Annually □ Alternate Years, starting ________
Semester(s) offered (check all that apply): ☑ Fall □ Spring
Summer Options (check all that apply): ☑ First 6 weeks □ Second 6 weeks □ 12 weeks

Credits by mode of instruction: Lecture: 3
Seminar: ________
Independent Study: ________
Lab/Studio: ________
Recitation/Discussion: ________
TOTAL CREDITS: 3

Primary Mode(s) of Delivery: ☑ Face-to-face □ Web-Enhanced (small on-line comp.)
On-Line Only □ Blended (significant on-line portion)

Time and Location – Call the Registrar’s Office at x4155 to find a time and location for the course.

Assigned Day(s): ☑ M □ Tu □ W □ Th □ F □ Sa □ Su
Assigned Time(s):
Assigned Building: TBD
Assigned Room: TBD

Co- and Pre-Requisites – Courses numbered 200 and above are normally expected to have prerequisites. When listing multiple prerequisites, please separate courses with “and” if both are required, or “or” if only one is required.

Prerequisite(s): EMEC 326 and EMEC 342 or instructor approval
Co-Requisite(s):

Course Description – Provide a course description of 40 words or less for the MSU Catalog.

Introduction to elastic and elastoplastic deformation, microfracture, and surface interactions at the micro- and nano-scale. Application of fundamental knowledge to control friction and wear behavior through lubrication, selection of materials and coatings in practical situations.
DEAN’S STATEMENT

The reviewing committees are being asked to take a closer look at the resources required for each proposed new course. In many cases new courses will replace existing courses and the new course request is effectively resource neutral, however that is not always the case. For example, a new elective course that would result in distributing an existing student population across a larger number of courses would represent a significant increase in expenditures for the new course, and no increase in total student credit hours. A funding mechanism for such a course would need to be identified. The Dean’s Statement is the place to document how the costs of the proposed new course will be covered.

Principles of Tribology (EMAT 461) is proposed by Dr. Roberta Amendola, a new faculty member in the College of Engineering. This course would serve as a professional elective for Mechanical Engineering seniors in the Materials Minor, and as a course option for graduate students in Mechanical Engineering, Chemical Engineering, and the Materials Science PhD program. In order to expand our offerings for professional electives in the college as well as help grow the interdisciplinary Materials Science PhD program additional course are required. This course has approval and suport from the departmental chair, the curriculum committee and the Dean’s office.
New Undergraduate Course Narrative
Montana State University
Updated August 23, 2012

Please provide the following information in narrative format. Substantive responses to all criteria are required. Although not required, a draft syllabus can also be helpful to the committee in understanding the details of the proposed course.

General Course Information

1. Requested Rubric, Course Number, and Core Designation (if any)

> EMAT 461

2. Course Title

> Principles of Tribology

3. Provide a general description of the course explaining the need for the course, its goals, and its overall structure. This is the most important part of the application and should offer a good sense of what students will experience by taking this class.

> The study of friction, wear, and lubrication has long been of enormous practical importance, since the functioning of many mechanical, electromechanical and biological systems depends on the appropriate friction and wear values. In recent decades, this field, termed tribology, has received increasing attention as it has become evident the wastage of resources (materials and money) resulting from high friction and wear.

This discipline is considered a branch of Material Science, since it is through materials development that tribological systems can be improved and optimized. However a large part of the investigated tribological systems comes from the design and analysis of wear components and surface therefore the content integrates very nicely with the field of mechanical engineering. Despite this fact many engineers ignore the word "tribology" and its meaning. Mechanical engineering students acquire a good knowledge of basic materials science, mechanical component design, heat transfer and fluid dynamic before graduation; a tribology course will complement and relate these classes. Students' background will be enriched through improved and focused materials knowledge that will result fundamental in their future career when solving real-world problems.

This course will focus on fundamental concepts as surface energy, elastic and elastoplastic deformation, microfracture, and surface interactions at the macro- and micro-scale. Additionally, special considerations will be given to the application of fundamental knowledge to control friction and wear behavior through lubrication and the selection of materials and coatings in practical situations. Modern experimental methods will be discussed and several case studies will be used to indicate how fundamental tribology knowledge can be applied in the design of components and systems.
This "principles of tribology" course is a unique offering within the MUS. It will be an undergraduate class offered as a professional elective for Mechanical Engineering seniors, it will support the minor in Materials and also the PhD in Material Science and Engineering degree. Since it is a versatile interdisciplinary course, that includes elements of engineering, chemistry, and Physics this 400 level course can therefore be appropriate for graduate students also.

4. Based on what types of student work (e.g., tests, homework assignments, papers, performances, etc.) will grades be determined?

> Midterm exam 1 (25%), Midterm exam 2 (25%), Term Paper (40%), HW (10%) Students are required to write a term paper on a subject of their choosing, once approved by the instructor. Paper format will be the standard one used for peer reviewed scientific journals.

5. Provide a course content outline containing all major topics plus a brief description of the material to be covered under each major topic heading.

**Introduction to tribology**
Definition and history of tribology, the several disciplines in the field of tribology, the consequences of friction and wear, the scope of tribology

**Solid surface characterization**
The nature of surfaces, technological surface making, residual stresses in processed surfaces roughness of surfaces and its evaluation methods, surface layers.

**Contact between solid surfaces**
Analyses of the contact, concept of asperities, real area of contact, adhesion and cohesion properties of solids, contact of nonconforming surfaces and temperature rise on sliding surfaces

**Friction**
Static, sliding and rolling friction, liquid mediated contact, friction of materials (metals and alloys, ceramic and polymers) solid lubricants.

**Wear**
Types of wear mechanism (adhesive, abrasive, fatigue, impact, corrosive and fretting), wear of materials (metals and alloys, ceramic, polymers)

**Lubrication**
Fluid film lubrication (hydrostatic, hydrodynamic and mixed), boundary lubrication (adsorbed gas, monolayer, multilayers, chemical films) and lubricants (principal classes of liquid lubricants, additives and greases)

**Designing for wear life and frictional performance**
Steps in designing for wear life, material selection, wear and friction testing and simulation, introduction to the diagnosis of tribological problems, surface modification processes.

**Tribological components and applications**
Common tribological components (bearings, gears, pistons and brushes), material processing (cutting tools, grinding and lapping processes, forming processes)
6. List required texts or other required references.

> The course text will be "Introduction to Tribology; Bharat Bhushan; Wiley (2nd ed. 2013)"

7. What are the estimated enrollment and student credit hour (SCH) production?

\[ \text{SCH} = \text{enrollment} \times \text{credits} \]

> 25 students \( \times \) 3 credits = 75 SCH

8. Will there be an enrollment cap that restricts enrollment below the level of student demand? If so, what is the enrollment cap and why is it necessary?

> no

9. Will course be a "restricted enrollment" course? If so, why is restricted enrollment necessary?

> no

10. Describe how the success of the course will be evaluated? ("End of semester student evaluations" is not the answer to the question. How will the instructor determine if the learning outcomes are being met, and how will the department determine if the course is fulfilling its intended purpose?)

> The paper required as a final, will demonstrate if the students have acquired the below listed learning outcomes for this course:

1) Describe surface topography, physico-chemical aspects of solid surfaces, and surface interactions.
2) Explain the mechanics of solid elastic and elastoplastic contacts.
3) Describe the various modes of wear: adhesive, delamination, fretting, abrasive, erosive, corrosive, oxidational (mild and severe) and melt.
4) Identify types of lubrication: boundary, solid-film, hydrodynamic, and hydrostatic lubrication.
5) Examine applications/case studies: sliding contacts, rolling contacts, bearing design, coating selection, and lubrication.
6) Explore the design of tribological surfaces and how to troubleshoot tribology problems.

The paper will require the discussion of more conceptual topics as material and or lubricant selection but also the analyses of the design equation (e.g. contact mechanics and temperature rise of sliding surfaces) for a selected tribological system where interacting surfaces in relative motion are involved.

11. Is the instructor a member of the regular faculty (i.e., tenured or tenure track)? If no, please describe the instructor’s qualifications, attach a vita, and provide a separate letter of support, signed by the department head (or appropriate unit director), addressing the instructor’s qualifications to teach this course.

> yes
Level of Offering

12. Has the course been offered previously under 280/291 or 480/491? If so, when? Under what number? What was the enrollment? What level of students took the course?

> no

14. Justify the level of course offering.

> The course is appropriate as a 400 level given that it presumes some prior experience with disciplines including mechanical component design, heat transfer and fluid dynamic that are all 300 level classes. It will be an undergraduate class offered as a professional elective for Mechanical Engineering seniors, it will support the minor in Materials and also the PhD in Material Science and Engineering degree. Since it is a versatile interdisciplinary course, that includes elements of engineering, chemistry, this 400 level course and Physics can therefore be appropriate for graduate students also.

Relationship to other Courses, Curricula, and Departments

14. Does this course build on an interrate with other courses in your curriculum or related curricula? If so, which ones?

> This course build up upon several courses in the curriculum. It includes material from the following courses: EMAT251/252, EMEC 326/342

15. Do the topics in the proposed course duplicate or reiterate those in other courses in this or any other department? If so, how do the coverage and educational experience differ and how is this duplication or reiteration justified? Also, what liaison (which is expected in cases of apparent overlap] has been conducted with other departments? Report reactions, both favorable and unfavorable.

> this course does not duplicate material from any other course in the College of Engineering

16. What programs [departments, colleges] will be impacted by the SCH production of this course? That is, where do you think the SCH in the proposed course are likely to come from? If the expected SCH production of the proposed course is greater than 1000, and the SCH are expected to come from other colleges, what steps have been taken to make the other units aware of the potential loss of SCH? Report reactions, both favorable and unfavorable.

> > 90% of the SCH will be generated by under graduate students in the Mechanical Engineering program. The remainder will be generated by graduate students within the Mechanical Engineering, Chemical Engineering, material minor and the Materials Science PhD programs. This course will relieve enrollment pressure on other professional elective courses offered to mechanical Engineering seniors during the fall semester
Tribology is the science and technology of interacting surfaces in relative motion and of related subjects and practices. Understanding the nature of these interactions and solving the technological problems associated with the interfacial phenomena is the essence of tribology. The following summarize briefly the fundamental interdisciplinary components of the course:

Physics: investigation contacting surfaces (e.g. sliding and rolling) from the mechanistic point of view and study of the wear forces, temperature rise in dry and lubricated systems, compression of lubricating fluids.

Material science: effect of plastic deformation on contacting surfaces, surface roughness and finishing from the microstructural point of view, controlling friction through material selection, protective coating deposition and selection, solid lubricants.

Chemistry: nature of the lubricants and chemical interaction between the lubricant and the contacting surfaces.

Mechanical Engineering: design and analyses of an improved tribological system where interacting surfaces in relative motion are involved. This involves all the above mentioned disciplines through conceptual topics as material and lubricant selection and the analyses of the design equation (e.g. contact mechanics and temperature rise of sliding surfaces) to solving real-life problems.

**Students Served**

This course is intended for students in:
- Mechanical Engineering under graduate program
- Mechanical Engineering and Chemical Engineering graduate programs
- Material minor
- Materials Science PhD program.

**Resources**

No additional resources are needed to offer this course. The CES Edu Pack software, already acquired by the Mechanical Engineering Department, will be used. CES EduPack includes the Materials and Processes Database, a unique, comprehensive, browsable information resource covering engineering materials (ceramics, metals and alloys, composites, polymers and elastomers).
and processes (shaping, joining, surface treatment). It will be fundamental resource while students are learning about material selection and optimization of tribological systems.

20. What existing information resources — print (books, journals, documents), audiovisual (videos, DVDs, CDs or other), and/or electronic (e-books, databases, electronic journals and web sites) — provided by the MSU Libraries will be used by students in this course? Provide examples as well as descriptive information. If additional information resources are necessary, please discuss those acquisitions with the library (M6549 Collection Development) at least three months prior to the beginning of the semester in which this course will be taught.

> To complete their homework assignments and the final paper, students will use MSU library electronic access for searching and viewing scientific and engineering journals.

**Other Supporting Material**

21. Include any additional information you feel is needed to support this request.

> n/a