Proposal Form For Addition And Revision Of Courses

1. Proposing College / School: College of Engineering
   Department: Mechanical Engineering

2. Course Prefix and Number: MECH5240/6240/6246

3. Effective Term: Fall 2012

4. Course Title: Boundary and Full-Film Lubrication
   Abbreviated Title (30 characters or less): Boundary and Full-Film Lube

5. Requested Action:
   - [ ] Renumber a Course
   - [x] Add a Course
   - [ ] Revise a Course

6. Course Credit:
   Contact/Group Hours: 3
   Scheduled Type (e.g.: Lab, Lecture, Practicum, Directed Study): Lecture
   Weekly or Per Term?: Weekly
   Credit Hours: 3
   Anticipated Enrollment: 45

   Maximum Hours (Repeatability): 3

   Total Credit Hours: 3

7. Grading Type:
   - [x] Regular (ABCDF)
   - [ ] Satisfactory/Unsatisfactory (S/U)
   - [ ] Audit

8. Prerequisites/Corequisites:
   Use "P:" to indicate a prerequisite, "C:" to indicate a corequisite, and "P/C:" to indicate a prerequisite with concurrency.
   MECH 3030 or Departmental Approval.

9. Restrictions: List specific restriction in space above.
   - [ ] College
   - [ ] Major
   - [x] Standing
   - [ ] Degree

10. Course Description:
   (20 Words or Less; exactly as it should appear in the Bulletin)
   Theory and techniques for the design and modeling of the different regimes of lubrication between surfaces and machine components in order to control friction and wear.

11. May Count Either:
    (Indicate if this particular course cannot be counted for credit in addition to another)
    Program Type: or Program Title: Requirement or Elective?
    (e.g.: minor, major, etc.) (e.g.: MS in Chemistry, Performance Option, Minor in Art) (required or optional?)
    Major: Mechanical Engineering: Elective
    Minor: Tribology: Elective

12. Affected Program(s):
    (Respond "N/A" if not included in any program; attach memorandum if more space is required)
    Major: Mechanical Engineering: Elective
    Minor: Tribology: Elective

13. Overlapping or Duplication of Other Units' Offerings:
    (If course is included in any other degree program, is used as an elective frequently by other unit(s), or is in an area similar to that covered by another college/school, attach correspondence with relevant unit)
    - [ ] Applicable
    - [x] Not Applicable
14. Justification: It will cover in depth the science and engineering of fluid lubrication, while concentrating on the complicated boundary lubrication regime and also lubricant chemical formulation. This course is an important elective for Tribology Minor students and also other engineering students.

(Include a concise, yet adequate rationale for the addition/revision of the course, citing accreditation, assessments (faculty, graduate, and/or external) where applicable)

15. Resources: None - no additional course-load is expected. This course will be added to the schedule of rotating technical electives and graduate courses. If demand increases enough that it needs to be taught more frequently, external funds will be used to purchase faculty time.

(Indicate whether existing resources such as library materials, classroom/laboratory space, and faculty appointments are adequate to support the proposed addition/revision; if additional resources are required, indicate how such needs will be met, referencing the appropriate level of authorization -- i.e.: Dean -- where necessary; if no additional resources or shifting of resources will be necessary, respond "Not Applicable")

16. Student Learning Outcomes: Upon completion of the course students will be able to:
1. Identify critical parameters in a lubricated system.
2. Make predictions of the performance and behavior of a lubricated system based on these critical parameters.
3. Design a lubricated system for the needs of a specific application, including geometry, lubricant, and surface properties.
4. Improve the properties of a machine component surface or lubricant to improve reliability.
5. Optimize existing and new lubrication systems to improve performance.

(State in measurable terms (reflective of course level) what students should be able to do when they have completed this course)

17. Course Content Outline:
1. Introduction [1 Lecture]
2. Types of Lubricants [3 Lectures]
3. Lubricant Properties [3 Lectures]
   Homework #1
4. Regimes of Lubrication (Striebeck) [3 Lectures]
5. Bearing Types and Loads [2 Lectures]
   Homework #2
6. Hydrodynamic Lubrication [2 Lectures]
7. Squeeze Film Bearings [2 Lecture]
8. Journal Bearings [2 Lectures]
   Homework #3
9. Exam #1
10. Thrust Bearings [2 Lectures]
11. Hydrostatic Bearings [2 Lectures]
   Homework #4
13. Compressible Gas Bearings [2 Lectures]
   Homework #5
14. Exam #2
15. Boundary Lubrication [2 Lectures]
16. Bearing Materials [2 Lectures]
17. Adhesive Friction [2 Lectures]
   Homework #6
18. Lubricant Additives and Chemistry [3 Lectures]
19. Tribofilm Mechanism and Formation [2 Lectures]
   Homework #7
20. Exams [3 Lectures]
21. Thermal Effects [2 Lectures]
22. Applications [3 Lectures]
   Exam #3
23. Homework: Homework will be checked for satisfactory completion on a ten point scale. Late homework will be deducted three points. Students may

(Provide a comprehensive, week-by-week breakdown of course content, including assignment due dates)
work in groups, but are strongly encouraged to work individual problems themselves. Graduate students will not be allowed to work in groups and will be given additional problems which require more depth of understanding. For instance, a graduate problem may require the derivation of a formulation or model.

Exams: All exams will be open book and notes. Exams and final will be open to all material covered in class and homework up to that point. The undergraduate (MECH 5240) projects will be presented during the regularly scheduled final exam period. However, the graduate student projects (MECH 6240/6246) will be presented during the final course periods so that the undergraduate students may also learn from them.

Project: A project will be assigned to the graduate students, but not the undergraduates. The project will use techniques in the course to design and optimize a tribological system. The undergraduate projects will also be presented at the end of the semester using a 10 minute presentation format during the final exam period, while the graduate students will present for 15-20 minutes. The undergraduate project grades will consist of 70% for report and 30% for presentation, while the ratio will change to 60% for report and 40% for presentation for the MECH 6240/6246 students. Again, the graduate student projects (MECH 6240/6246) will be presented during the final course periods so that the undergraduate students may also learn from them. The graduate students will pick their own project subject, but will require approval from the course instructor. The graduate project should incorporate some numerical modeling or experimental work. It is expected to be more research formulated in nature and display a broader depth of knowledge. It is also expected that the graduate students prepare their results in a format that is similar to what would be submitted to a technical journal.

(List all quizzes, projects, reports, activities and other components of the course grade -- including a brief description of each assignment that clarifies its contribution to the course's learning objectives)

19. Rubric and Grading Scale:

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<thead>
<tr>
<th>Component</th>
<th>MECH 5240</th>
<th>MECH 6240/6246</th>
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<tbody>
<tr>
<td>Homework</td>
<td>15%</td>
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<tr>
<td>Exam #1</td>
<td>20%</td>
<td>Exam #1 15%</td>
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<td>Exam #2</td>
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<td>Project</td>
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(List all components of the course grade -- including attendance and/or participation if relevant -- with point totals for each; indicate point totals and ranges or percentages for grading scale; for S/AU grading, detail performance expectations for a passing grade)

20. Justification for Graduate Credit:

The course will require graduate students to obtain a thorough understanding of the multi-disciplinary field of lubrication. This includes the coupling between chemistry, fluid dynamics, thermodynamics and solid-state physics. Graduate students will also be required to complete a project requiring independent critical thinking and research.

(Include a brief statement explaining how the course meets graduate educational standards (i.e.: rigorous standards for evaluation, development of critical thinking and analytical skills, etc.))
(Included below are standard statements regarding course policies. If necessary, a statement may be altered to reflect the academic policies of individual faculty members and/or the academic unit or department, provided that there is no conflict with the Tiger Cub, Faculty Handbook, or any existing university policy.)

POLICY STATEMENTS

Attendance: Although attendance is not required, students are expected to attend all classes, and will be held responsible for any content covered in the event of an absence.

Excused Absences: Students are granted excused absences from class for the following reasons: illness of the student or serious illness of a member of the student’s immediate family, the death of a member of the student’s immediate family, trips for student organizations sponsored by an academic unit, trips for university classes, trips for participation in intercollegiate athletic events, subpoenas for a court appearance, and religious holidays. Students who wish to have an excused absence from class for any other reason must contact the instructor in advance of the absence to request permission. The instructor will weigh the merits of the request, and render a decision. When feasible, the student must notify the instructor prior to the occurrence of any excused absences, but in no case shall such notification occur more than one week after the absence. Appropriate documentation for all excused absences is required. Please see the Tiger Cub for more information on excused absences.

Make-Up Policy: Arrangement to make up a missed major examination (e.g., hour exams, mid-term exams) due to properly authorized excused absences must be initiated by the student within one week of the end of the period of the excused absence(s). Except in unusual circumstances, such as the continued absence of the student or the advent of university holidays, a make-up exam will take place within two weeks of the date that the student initiates arrangements for it. Except in extraordinary circumstances, no make-up exams will be arranged during the last three days before the final exam period begins.

Academic Honesty Policy: All portions of the Auburn University student academic honesty code (Title XII) found in the Tiger Cub will apply to university courses. All academic honesty violations or alleged violations of the SGA Code of Laws will be reported to the Office of the Provost, which will then refer the case to the Academic Honesty Committee.

Disability Accommodations: Students who need special accommodations in class, as provided for by the Americans With Disabilities Act, should arrange for a confidential meeting with the instructor during office hours in the first week of classes (or as soon as possible if accommodations are needed immediately). The student must bring a copy of their Accommodation Letter and an Instructor Verification Form to the meeting. If the student does not have these forms, they should make an appointment with the Program for Students with Disabilities, 1298 Haley Center, 844-2096 (V/T).
MECH 5240/6240/6246 – Boundary and Full-Film Lubrication

Summary: Theory and techniques for making measurements associated with tribology, such as surface roughness, surface chemistry, friction, and wear. Students will be taught to use the equipment during a weekly laboratory.

Class Schedule: Weekly Three Hour Laboratory

Prerequisites: MECH 3230, MECH 3030 or INSY 3800 or instructor permission (equivalent classes may be used for MECH 6230/6236).


Supplemental Texts and References:

Journals (for graduate students):
- *Journal of Tribology*, American Society of Mechanical Engineers.
- *Tribology Transactions*, Society of Tribologists and Lubrication Engineers.

Course Coordinator: Robert L. Jackson, Associate Professor of Mechanical Engineering

Course Objectives:
This course will present and demonstrate to the students the following:

1. Manipulation and identification of the parameters which govern performance of lubricated systems that are found in engineering practice. (Program Outcomes 1, 2, 7)

2. Apply the Strubeck curve and friction coefficient to determine the operating regime of lubrication for a system (Program Outcomes 1, 2, 4, 7, 12).

3. Applied lubrication theory for hydrostatic and hydrodynamic bearing applications. (Program Outcomes 1, 2, 4, 7, 12)

4. Application of asperity contact and friction theories in boundary lubricated contacts. (Program Outcomes 1, 2, 4, 7, 12)

5. The fundamental solid mechanics, fluid mechanics, chemistry and physics which govern lubricated systems. (Program Outcomes 1, 2, 4, 7, 12)
Course Outcomes:
Upon completion of the course students will be able to:

1. Identify critical parameters in a lubricated system. (Course Objective 1)
2. Make predictions of the performance and behavior of a lubricated system based on these critical parameters. (Course Objectives 1, 2, 3, 4)
3. Design a lubricated system for the needs of a specific application, including geometry, lubricant, and surface properties. (Course Objectives 1, 2, 3)
4. Improve the properties of a machine component surface to improve reliability. (Course Objectives 1, 4)
5. Optimize existing and new lubrication systems to improve performance. (Course Objectives 1, 2, 3)

Representative Lecture Topics and Coverage (50 Minute Lecture Periods)

Lecture Topic
1. Introduction [1 Lecture]
2. Types of Lubricants [3 Lectures]
3. Lubricant Properties [3 Lectures]
4. Regimes of Lubrication (Stribeck) [3 Lectures] 10
5. Bearing Types and Loads [2 Lectures] 12
7. Squeeze Film Bearings [2 Lecture] 16
15. Adhesive Friction [2 Lectures] 32
16. Lubricant Additives and Chemistry [3 Lectures] 35
17. Tribofilm Mechanism and Formation [2 Lectures] 37
19. Applications [3 Lectures] 42
20. Exams [3 Lectures] 45
Total: 45 Lectures
Course Grading: The course will be graded through homework, exams and a group design project that will be due at the end of the semester. The graduate version (MECH 6240/6246) will require more in depth homework assignments, additional problems on tests, and instead of a group project, an individual project that should be at the graduate research level. The undergraduate design project will be simple enough to be completed in one semester.

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Grading Scale:
- A 100-90%
- B 90-80%
- C 80-70%
- D 70-60%
- F <60%

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Course Policies:

**Cheating:** Cheating or academic misconduct on Exams will not be tolerated and will be reported to the Academic Honesty Committee as outlined in the Tiger Cub student handbook. This includes sharing answers and information during exams.

**Student Accommodations:** Students who need accommodations are asked to arrange a meeting during office hours the first week of classes, or as soon as possible if accommodations are needed immediately. If you have a conflict with my office hours, an alternate time can be arranged. To set up this meeting, please contact me by E-mail. Bring a copy of your Accommodation Memo and an Instructor Verification Form to the meeting. If you do not have an Accommodation Memo but need accommodations, make an appointment with The Program for Students with Disabilities, 1244 Haley Center, 844-2096 (V/TT).

**Contribution to ME Curriculum:** Undergraduate Technical Elective

**Professional Component Contribution:** Engineering Science and Design 3 Hours

**Prepared by:** Robert L. Jackson, August, 2010