Proposal Form For Addition And Revision Of Courses

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

2. Course Prefix and Number: MECH 4410
   3. Effective Term: 2013 Summer

4. Course Title:
   Abbreviated Title (30 characters or less):
   Engines

5. Requested Action:
   - Renumber a Course
     Current Course Number: MECH 4410
     Proposed Course Number: ME 5830/6830
   - Add a Course
   - Revise a Course
     Type of Revision:

6. Course Credit:
   Contact/Group Hours | Scheduled Type (e.g.: Lab, Lecture, Practicum, Directed Study) | Weekly or Per Term? | Credit Hours | Anticipated Enrollment
   Maximum Hours (Repeatability): 3 | lecture | weekly | 3 | 20
   Total Credit Hours: 3

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

8. Prerequisites/Corequisites:
   P: ENGR 2200;
   or ENGR 2010 plus any one of: AERO 3110; CHEN 2610; CIVL 3110;
   MECH 3030

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

10. Course Description:
    (20 Words or Less: exactly as it should appear in the Bulletin)
    Analysis, design, and application issues in internal combustion engines.
    Characteristics, thermodynamics, thermochemistry, unsteady multi-phase fluid dynamics, stresses, vibration, noise, mechanisms.

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

12. Affected Program(s):
    (Respond "N/A" if not included in any program; attach memorandum if more space is required)
    major Bachelor in Mechanical Engineering
    major MS/PhD in Mechanical Engineering

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
    - Not Applicable
14. Justification: Current undergraduate elective in Engines (MECH 4410) stops short of really useful engine design and characterization outcomes. Extending the course content to that appropriate for a graduate elective better supports existing programs in automotive engineering at Auburn, and supports expansion of the automotive industry in the state.

(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. Same resources as presently used for MECH 4410.

(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: Course Outcomes
   Individual students will demonstrate the ability to:
   1. Evaluate various standard measures of engine design and performance.
   2. Evaluate typical air-standard, fuel-air, and heat release (continuous) engine cycles fired by a variety of fuels.
   3. Apply advanced engine characteristics (heat transfer, charge motion, tailored fuel injection, intake pulsing, exhaust pulsing, friction) to heat release cycle predictions.
   4. Predict mechanical loads and characteristics of vibration and noise for engines.
   5. Disassemble, repair, reassemble, and operate an example internal combustion engine.

(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:

   Week 1: Engine characteristics
   Week 2: Air-standard cycles
   Week 3: Thermochemistry and fuels
   Week 4: Fuel-air cycles
   Week 5: Heat release cycles
   Week 6: Compressible flow networks
   Week 7: Intake tracts
   Week 8: Disperse gas/liquid flows
   Week 9: Fuel injection
   Week 10: Charge motion and heat transfer
   Week 11: Exhaust tracts and emissions
   Week 12: Load transfer in engines
   Week 13: Vibration
   Week 14: Noise
   Week 15: Friction

(Provide a comprehensive, week-by-week breakdown of course content, including assignment due dates)

18. Assignments / Projects: Homework
    Exercises will be assigned weekly. Solutions to exercises will be posted. It is expected that students will compare their answers to the posted solution and resolve any discrepancies. Most exercises will require computer-assisted solution. Any language may be used, but posted solutions will be written in Matlab.

   Exams
   There will be a Midterm and a Final exam. The Final will be comprehensive. Exams will be closed book, except for one side of one 8½ in. × 11 in. sheet (any font or margins) in the midterm, and both sides in the Final. Exam papers that are difficult to understand, whether by poor penmanship or by an opaque flow of logic, will be assumed to be
meaningless and scored accordingly.

Project 1
Each student will fully disassemble an internal combustion engine, document each significant part with an illustration and explanation of its design features and effects, reassemble the engine, demonstrate to the instructor that the engine will idle, hands-off, under no load, and prepare a written report describing the characteristics of this engine, along with simulation results to demonstrate the effects. It is expected that course material (readings, exercises, simulations) will be applied to this engine as an example, and that results and conclusions of these applications will be reported. Groups of up to three students may share an engine and assist each other in the teardown, recondition, and build processes; however, each student must turn in an individual written report.

Project 2
Students registered for the 6000 version of the course will also perform a research project combining and extending analytical techniques developed in the course. The object of the project will be either improved engine characterization/analysis, or advancement of engine technology and understanding.

(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:

<table>
<thead>
<tr>
<th>Grading and Evaluation Procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>6000 level</td>
</tr>
<tr>
<td>Homework 20%</td>
</tr>
<tr>
<td>Midterm 20%</td>
</tr>
<tr>
<td>Final 30%</td>
</tr>
<tr>
<td>Project 1 30%*</td>
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<tr>
<td>* Project 1 grade will be reduced by 50% if the engine cannot be demonstrated to run unassisted after reassembly.</td>
</tr>
</tbody>
</table>

| 6000 level                        |
| Homework 20%                     |
| Midterm 10%                      |
| Final 20%                        |
| Project 1 20%                    |
| Project 2 30%                    |

(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/U grading, detail performance expectations for a passing grade)

20. Justification for Graduate Credit:
To support advanced development of internal combustion engine technology, it is necessary for students to understand physical concepts and apply analytical skills far beyond the fundamentals of mechanical engineering. In particular, current engine technological progress is driven by details of multi-phase fluid flow (fuel/air) and compressible flow (wave mechanics). Without the ability to apply these advanced concepts, modern engine technology is reduced to empirical (and generally proprietary) experimental coefficients. There is a need for a course at the 5000/6000 level which connects to the fundamentals of thermodynamics and fluid mechanics, but also provides a key for extension to current engine research and development. The analytical skill necessary to apply these difficult physical concepts appropriately deserves graduate credit.

(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/TT).
Course Number: MECH 4410  
Course Title: Engines  
Credit Hours: 3 (LEC 3)  
Prerequisites: ENGR 2200; or ENGR 2010 plus any one of [AERO 3110, CHEN 2610, CIVL 3110, MECH 3030] (functionally, thermo I and fluid mechanics)

Lecture Schedule  
TR 12:00 -1:50 p.m., Shelby 1126

Instructor  
Dr. Peter D. Jones, Mechanical Engineering, 3418G Wiggins, 334-844-3368, jonesp1@auburn.edu, Office Hours W 12:00 p.m. to 2:00 p.m. and R 2:00 p.m. to 4:00 p.m.

Course Objectives  
Upon completion of this course the student will be able to:
1. Apply knowledge of basic thermodynamics and fluid mechanics to prediction of the operating characteristics of internal combustion engines of various types.
2. Understand the effect of internal combustion engine design parameters on performance and emissions.
3. Demonstrate familiarity with an internal combustion engine’s internal mechanisms.

Course Outcomes  
Individual students will demonstrate the elementary ability to:
1. Evaluate various standard measures of engine design and performance.
2. Evaluate typical fuel-air engine cycles and heat release (continuous) cycles fired by a variety of fuels.
3. Apply advanced engine characteristics (heat transfer, charge motion, friction) to fuel-air and heat release cycle predictions.
4. Disassemble, repair, reassemble, and operate an example internal combustion engine.

Textbook  

Textbook readings scheduled as lecture subject matter should be read before the relevant class.

Supplementary material will be posted on http://www.eng.auburn.edu/~pjones/MECH4410.html

Homework  
Exercises will be assigned regularly. Solutions to exercises will be posted at: http://www.eng.auburn.edu/~pjones/MECH4410.html. It is expected that students will compare their answers to the posted solution and resolve any discrepancies. Some exercises will require computer-assisted solution. Any language may be used, but posted solutions will be written in Matlab.
Exams
There will be a Midterm and a Final. The Final will be comprehensive. Exams will be closed book, except for one side of one 8½ in. × 11 in. sheet (any font or margins) in the Midterm, and both sides in the Final.

Project
Each student will:

- Fully disassemble an internal combustion engine.
- Document significant parts with illustrations and explanations of features and effects.
- Simulate the engine to the extent addressed by the course and explain its overall function and performance.
- Reassemble the engine.
- Demonstrate to the instructor that the engine will idle (hands-off, no load).
- Prepare a written report describing the characteristics of this engine.

Groups of up to three students may share an engine and assist each other in the teardown, recondition, and build processes; however, each student must turn in an individual written report.

Tentative Schedule

<table>
<thead>
<tr>
<th>Tuesday</th>
<th>Thursday</th>
</tr>
</thead>
<tbody>
<tr>
<td>17 May</td>
<td>Subject: Engine introduction and characteristics (Chaps.1,2)</td>
</tr>
<tr>
<td>22 May</td>
<td>24 May</td>
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<tr>
<td>Subject: Gas cycles (Chap.3)</td>
<td>Subject: Gas cycles</td>
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<tr>
<td></td>
<td>Homework Due: Engine introduction and characteristics</td>
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<tr>
<td>29 May</td>
<td>31 May</td>
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<tr>
<td>Subject: Thermochemistry and fuels (Chap.4)</td>
<td>Subject: Thermochemistry and fuels</td>
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<tr>
<td></td>
<td>Homework Due: Gas cycles</td>
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<tr>
<td>5 Jun</td>
<td>7 Jun</td>
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<tr>
<td>Subject: Fuel-air cycles (notes)</td>
<td>Subject: Fuel-air cycles</td>
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<tr>
<td></td>
<td>Homework Due: Thermochemistry and fuels</td>
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<td>12 Jun</td>
<td>14 Jun</td>
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<tr>
<td>Subject: Heat release cycles (notes)</td>
<td>Subject: Heat release cycles</td>
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<td></td>
<td>Also: Midterm Exam</td>
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<td></td>
<td>Homework Due: Fuel-air cycles</td>
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<td>19 Jun</td>
<td>21 Jun</td>
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<tr>
<td>No class (FSAE Nebraska)</td>
<td>“No Classes - MS-I Reading Period”</td>
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<tr>
<td>26 Jun</td>
<td>28 Jun</td>
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<tr>
<td>Subject: Air and fuel induction (Chap.5)</td>
<td>Subject: Air and fuel induction</td>
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<td></td>
<td>Homework Due: Heat release cycles</td>
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<td>3 Jul</td>
<td>5 Jul</td>
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<tr>
<td>Subject: Charge fluid motion (Chap.6)</td>
<td>Subject: Combustion (Chap.7)</td>
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<td></td>
<td>Homework Due: Air and fuel induction</td>
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<td>Date</td>
<td>Subject</td>
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<tr>
<td>10 Jul</td>
<td>Exhaust flow (Chap.8)</td>
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<tr>
<td>17 Jul</td>
<td>Heat transfer (Chap.10)</td>
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<tr>
<td>24 Jul</td>
<td>Mechanical design (notes)</td>
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<tr>
<td>31 Jul</td>
<td>Final Exam (12:00 p.m. to 2:30 p.m.)</td>
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</tbody>
</table>

### Grading and Evaluation Procedures

<table>
<thead>
<tr>
<th>Grading basis:</th>
<th>Course Requirements:</th>
<th>Grading System:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, B, C, D, F</td>
<td>Homework</td>
<td>25%</td>
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<tr>
<td></td>
<td>Midterm</td>
<td>15%</td>
</tr>
<tr>
<td></td>
<td>Final</td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td>Project Report</td>
<td>30%*</td>
</tr>
</tbody>
</table>

* Project Report grade will be reduced by 50% if the engine cannot be demonstrated to run unassisted after reassembly.

### Accessibility
The policy of Auburn University is to provide accessibility to its programs and activities, and reasonable accommodation for persons defined as having a disability under Section 504 of the Rehabilitation Act of 1973, as amended, and the Americans with Disabilities Act of 1990. Students needing special accommodations should see the instructor as soon as possible, or contact the Students with Disabilities Program office at (334) 844-5943 (Voice/TT).

### Attendance
Class attendance is expected but not recorded. Late submission of assigned work or make-up examinations will be allowed only if accompanied by an approved University excuse.

### Behavior
Professional behavior is expected of all class participants. No spitting, swearing, or carrying on.

### Contingency
If normal class and/or lab activities are disrupted due to illness, emergency, or crisis situation, the syllabus and other course plans and assignments may be modified to allow completion of the course. If this occurs, an addendum to your syllabus and/or course assignments will replace the original materials.

### Evacuation
When the alarm bell rings, go to your station.
Honesty
All portions of the Auburn University Student Academic Honesty Code, as found in the Tiger Cub and defined in the SGA Code of Laws, Title XII, will apply in this class. The honesty code may be viewed at:

Religious Holidays
Students requesting absence or delay of due dates in order to observe religious holidays must do so in writing to the instructor no less than two weeks prior to the beginning of the anticipated observance.