AME 436 – Energy and Propulsion - Spring 2016

Instructor: Paul Ronney
Office: Olin Hall 430J, 740-0490, ronney@usc.edu
Office hours: Thursdays 1:00 to 4:00 pm; other times by appointment

Teaching Assistant:
DJ Lee (dongjlee aat usc dot edu)
Office hours: Thursdays 11:00 am – 12:00 pm, Fridays 10:00 am – 12:00 pm, VHE 202

Graders:
Robert Lee (robertjaehoonlee aat gmail dot com); Zengsu Shan (zshan aat usc dot edu)
(For questions about solving homework problems, please contact PDR or DJ, not the graders.)

Lecture: 6:40 – 9:20 PM Wednesdays, OHE 132

Final: Wednesday, May 4, 7:00 - 9:00 pm.

Web page: http://ronney.usc.edu/ame436/

Required texts:
None; course will be taught primarily from lecture notes

Possibly useful supplemental materials:

- Heywood, J. B., Internal Combustion Engine Fundamentals, McGraw-Hill, 1988 (http://catalogs.mhhe.com/mhhe/viewProductDetails.do?isbn=007028637X)
- Mattingly, J. D., Elements of Propulsion: Gas Turbines and Rockets, AIAA Education Series, 2006 (https://www.aiaa.org/PubDetail.aspx?id=12218)
- Farokhi, S., Aircraft Propulsion, 2nd Ed., Wiley, 2014 (http://www.wiley.com/WileyCDA/WileyTitle/productCd-1118806778.html)
- Turns, S., An Introduction to Combustion, 3rd Ed., McGraw-Hill, 2012 (http://catalogs.mhhe.com/mhhe/viewProductDetails.do?isbn=0073380199)

Grading:

Midterm exams (2)	20% each
Final exam	30%
Homework	30%

- Exams will be open book and notes
- Homework problems will be assigned Fridays and due the following Friday at 4:30 P.M. **Late homework will be marked down 10 points (out of 100 total) per working day late.** The fact that it was "someone else's fault" (e.g., your roommate overslept or forgot to turn it in, your computer crashed, the printer ran out of ink, etc.) doesn't matter. Since everyone has some valid reason for missing or doing poorly on at least one homework assignment, your lowest homework score will be eliminated.

- The deadline for disputing grading of homework or exams is **two weeks from the day the graded material is returned.** So if you pick up your graded material three weeks after it's available, that's too late to "file a claim."
- To request reconsideration of a homework grade for any reason, send an email to the graders via ame436usc@gmail.com. Attach a picture of the disputed part along with an explanation as to why you believe the grade should be changed. Send a separate email for each problem you believe needs reconsideration.
- Electronic versions of homework and exam solutions will not be posted. Hard copies will be available for on-campus students; DEN students will have solutions sent to their individual DEN mailboxes.
- There will be no "extra credit" assignments. If extra credit is offered to one student, I have to offer it to every student, in which case it becomes just another assignment and the number of assignments is already enough for the course.
- Grading policy
    - The average course grade will be close to the Viterbi School average of about 3.3/4.0, perhaps a bit higher if I decide in the end that this class is better than average, or a bit lower if... well you get the idea. But it's very unlikely that the average grade will be above 3.4 or below 3.2.
    - I'll adjust the weighting of the two midterms separately so that getting an average grade on either will give you the same number of points toward your total course points. The same consideration applies to the final exam, though the final is weighted 1.5 times higher than each midterm.
    - I try hard not to give any grade below C, since you need to maintain a C average to stay here, so if I give you a grade below C that implicitly means I believe you effectively failed the course. Rarely do I have to give below a C to someone who did all the work. The major source of low grades is students not doing the homework and thus losing 30% of their grade. Viterbi students as a group are extremely competitive in the sense that the standard deviation of scores is small, so losing 30% of your total score would typically move one from the A range to the C range.

Collaboration policy:

- You may
    - Work with others to find solutions to lecture and lab homework assignments
    - Study with others for exams
- You may NOT
    - Copy homework assignments from others – even if you work together, you must prepare and turn in assignments that were created by you only
    - Work together during exams
- **Violators will be reported to the Office of Committee for Student Judicial Affairs and Community Standards (http://www.usc.edu/student-affairs/SJACS/)**

Suggestions for how to do well in this class (applies to almost any class, really):

1. **Come to lectures!** There IS a very good correlation between attendance and performance in the course. The lecture notes are a **supplement** to lectures, not a replacement. **Do not assume that you can learn everything by reading the lecture notes. If a topic is clarified or expanded upon in class but not in the lecture notes, it's fair game for homework and**

exam questions. The fact that you "didn't know" something that was discussed in class is not an excuse. Also, exams will mirror lectures … obviously the stuff I discuss most in class is the stuff mostly likely to appear on exams.

2. **Read the lecture notes!** Everything on the homework and exams is covered in class and in the lecture notes.
3. **Pick up your graded homework and exams and their solutions.** It's remarkable that many students don't. How can you know what you did correctly or incorrectly without comparing your answers to the "correct" ones? And without such feedback, how can you do better on subsequent homeworks and exams?
4. **Tips for studying for and taking exams**
    1. Do the posted sample exams, homework and examples in lecture notes without looking at answers. Some students have a tendency to spend too much time on the first problem and try to get it "just right" before moving on to the next one. If you're particularly prone to that, after getting your graded exam back, try re-doing the exam backwards, i.e. last problem to first problem.
    2. Since electronic versions of the lecture notes are not allowed during exams, put hard copies of all the lecture notes into a 3-ring binder then (and here's the important part) create a system of tabs or some type of indexing (e.g. where key topics like "burning velocity" "T-s diagrams" "knock" etc. are located) so you can find things quickly. Just the process of doing this organization will force you to ask yourself, "What are the important topics in this course? Where can I find them in the notes?"
    3. Work both independently and as part of a group. As much as you may think otherwise, you really don't understand something until you have to explain it to someone else
    4. During the exam, budget your time and pick the low hanging fruit.

Academic integrity

Viterbi Honor Code (developed by Viterbi students):

- Engineering enables and empowers our ambitions and is integral to our identities. In the Viterbi community, accountability is reflected in all our endeavors.
- Engineering+ Integrity. Engineering+ Responsibility. Engineering+ Community. Think good. Do better. Be great.
- These are the pillars we stand upon as we address the challenges of society and enrich lives.

SCampus, the Student Guidebook, (http://scampus.usc.edu) contains the University Student Conduct Code (see University Governance, Section 11.00).

Academic Conduct

Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Section 11, Behavior Violating University Standards https://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriate-sanctions/. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, http://policy.usc.edu/scientific-misconduct/.

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the Office of Equity and Diversity http://equity.usc.edu/ or to the Department of Public Safety http://capsnet.usc.edu/department/department-public-safety/online-forms/contact-us. This is important for the safety whole USC community. Another member of the university community – such as a friend, classmate, advisor, or faculty member – can help initiate the report, or can initiate the report on behalf of another person. The Center for Women and Men http://www.usc.edu/student-affairs/cwm/ provides 24/7 confidential support, and the sexual assault resource center webpage sarc@usc.edu describes reporting options and other resources.

Support Systems

A number of USC's schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the American Language Institute http://dornsife.usc.edu/ali, which sponsors courses and workshops specifically for international graduate students. The Office of Disability Services and Programs http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, USC Emergency Information http://emergency.usc.edu/will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology.

Accreditation Board for Engineering and Technology (ABET) course objectives:

To introduce the student to the design and performance of automotive and aircraft engines including power output, efficiency and emissions.

ABET Course Outcomes: The student will be able to

1. Understand the differences between the basic types of internal combustion engines (premixed-charge reciprocating, non-premixed charge reciprocating, turbojet, turbofan, etc.)
2. Understand the advantages and disadvantages of internal combustion engines compared to alternatives such as steam, electric and solar power
3. Calculate flame temperature for an idealized fuel-air mixture (constant specific heats, no dissociation, etc.)
4. Understand qualitatively how ideal flame temperatures are affected by non-ideal factors such as variable specific heats, dissociation, heat losses, etc.
5. Understand the difference between the following four types of combustion processes: laminar premixed flames, turbulent premixed flames, homogeneous reaction (knock) and non-premixed spray or droplet flames
6. Understand the basics of how NO, CO, unburned hydrocarbons and soot emissions are formed in engines and how they are minimized.
7. Analyze an ideal engine cycle (for either reciprocating or steady-flow engines) using P-v and T-s diagrams
8. Analyze the performance (indicated mean effective pressure, thrust specific fuel consumption, thermal efficiency, etc.) of an ideal Otto, Diesel, Brayton, etc. thermodynamic cycle.
9. Estimate the performance (indicated mean effective pressure, thrust specific fuel consumption, thermal efficiency, etc.) of a Otto, Diesel, Brayton, etc. thermodynamic cycle using a chemical thermodynamics computer program such as GASEQ.
10. Estimate the effect of non-ideal processes (throttling, slow burn, heat losses, knock, compressor/turbine losses, etc.) on an engine cycle using P-v and T-s diagrams
11. Estimate how these non-ideal processes affect engine design and performance.
12. Understand the basic performance and design considerations of hypersonic propulsion systems and how they are analyzed.

AME 436 Tentative schedule

Week	Date	Subject(s)	Lecture	Optional readings	HW
Introduction					
1	1/13	Engine types; alternatives to airbreathing combustion engines	PDR		
Chemical thermodynamics and combustion					
2	1/20	Fuels, chemical thermodynamics	PDR	Heywood 3, 4; Turns 2	
3	1/27	Chemical thermodynamics	PDR		1A
4	2/3	Basics of combustion	PDR	Turns 4, 5, 8, 9, 10	1D
5	2/10	Pollutant formation	PDR	Heywood 11; Turns 15	2A
Unsteady-flow engines					
6	2/17	Basic operating principles, design and performance parameters	PDR	Heywood 2	2D
7	2/24	Midterm #1 – covering material from weeks 1 – 5	MT1	Heywood 5.1 – 5.3	
		Using P-V and T-s diagrams	PDR		
8	3/2	Ideal cycle analysis	PDR	Heywood 5.4 – 5.7	3A
9	3/9	Non-ideal cycle analysis	PDR	Heywood 5.8	3D, 4A
	3/16	**Spring break**	XXX	XXX	
10	3/23	Combustion in engines: knock; ignition, misfire; emissions	PDR	Heywood 9, 10	4D
Steady-flow engines					
11	3/30	Thrust and aircraft range; compressible flow	PDR	Mattingly 4	
12	4/6	Midterm #2 – covering material from weeks 6 – 10	MT2	Mattingly 3	5A
		Compressible flow (continued)	PDR		
13	4/13	Ideal performance of turbojets and turbofans	PDR	Mattingly 5.1 – 5.8	5D
14	4/20	Non-ideal performance	PDR	Mattingly 5.9 – 5.11	6A
15	4/27	Hypersonic propulsion	PDR	Mattingly 6, 7	6D, 7A
	5/4		FIN		7D

The readings are optional, not required. You will not be responsible for material in these readings that is not covered in lectures or the lecture notes.

Legend:

PDR	PDR lectures
PT	Pre-taped lecture (PDR out of town) (Pre-taping times to be announced).
MTn	Midterm exam #n
XXX	Break/end of semester
nA	Homework n assigned
nD	Homework n due

Homework topics:

1. Chemical thermodynamics
2. Combustion and emissions
3. Ideal cycle analysis
4. Unsteady flow engines
5. Thrust and compressible flow
6. Steady flow (propulsion) engines
7. Hypersonic propulsion; practice problems for final exam