



**AME 513b: Fundamentals and Applications of
Combustion II**

Units: 4

Spring 2020 — Monday & Wednesday 9:00 — 10:50 am

Location: OHE 100C

Instructor: Paul Ronney

Office: OHE 430J

Office Hours: Thursdays 1:00 - 4:00 pm

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Office Hours: Fridays 9 am - noon

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Course Description

This course builds upon the fundamental knowledge students have acquired in AME 513a (Principles of Combustion) to learn how apply this knowledge to practical combustion problems. After a review and extension of some of the material presented in AME 513a, students are introduced to analytical methods in combustion research, then these methods are applied to several core combustion phenomena - stretch effects, stability, ignition and extinction of flames. These principles are then used to develop understanding of several key combustion phenomena - turbulence effects on combustion, detonations, and finally electrical power generation and propulsion at small scales. The course concludes with a discussion of emerging technologies and future needs in combustion research. Course assignments include traditional problem sets, critical reviews of student-chosen classic papers in the fields covered, and a capstone-like project, namely a "White Paper" proposing an original research project based on the knowledge accrued during the course.

Learning Objectives and Outcomes

It is expected that after completing this course, students will be able to apply fundamental and applied knowledge they have acquired to both fundamental research topics and practical combustion systems. Of particular importance is that the students be able to critically assess existing research and identify knowledge gaps in the current state-of-the-art, as evidenced by the "White Paper" research proposal.

Prerequisite(s): AME 513a (Fundamentals and Applications of Combustion I)

Co-Requisite(s): none

Concurrent Enrollment: none

Recommended Preparation: Review knowledge of combustion obtained in AME 513a.

Course Notes

- Grading Type: Letter grade
- Weekly lecture material (PowerPoint slides and journal articles) will be posted online in advance.
- All lectures will be posted on the USC Distance Education Network website (<https://courses.uscdcn.net/d2l/login>).
- This course will use the Piazza platform (<http://www.piazza.com/>) for online discussion. Please submit all questions related to homework assignments, logistics and the final exam through Piazza (rather than directly to the instructor) so that other students can benefit from the answers. You can submit questions anonymously if you so desire. If you are not automatically enrolled in Piazza, please contact the instructor.
- Videoconferencing is available during office hours for DEN students using the BlueJeans platform (<https://viterbigrad.usc.edu/technical-support/bluejeans/>). Please contact the instructor if interested.

Required Readings and Supplementary Materials

Lectures will be delivered via weekly PowerPoint presentations, supplemented by readings of review articles and seminal research papers on the topics covered. No textbook will be required, however, a recommended general combustion textbook is S. R. Turns, An Introduction to Combustion, 3rd Ed.: <http://mheducation.com/highered/product/introduction-combustion-concepts-applications-turns/M0073380199.html>

Description and Assessment of Assignments

Each homework assignment will consist several analytical/computational problems on the topics covered during the assignment period plus a report/review on a scientific paper chosen from an approved list.

White Paper

In the 4-page White Paper, students will identify a need for new research related to one of the topics discussed in class, justify this need, and propose a line of investigation to address the question(s) raised. An example of a White Paper is given at <http://ronney.usc.edu/AME513b/SampleWhitePaper.pdf>.

Grading Breakdown

Homework #	Description	% of total grade
1	Extension of AME 513a: chemical kinetics, nonpremixed flames	10
2	Analytical methods in combustion	10
3	Aerothermodynamics of combustion - extinction, ignition, stability	10
4	Turbulent combustion	10
5	Detonations and applications	10
6	Catalytic combustion; microscale combustion and power generation	10
7	White paper	15
---	Final exam	25

Grading policy

- Grading will be on a curve, with the average course grade close to the Viterbi School average for graduate courses.
- The White Paper will be graded on the following basis:
 - Justification of the need for the research 30%
 - Originality of the proposed research 30%
 - Clarity of the presentation of the proposed concept 40%
- Late assignments will be marked down 10 points (out of 100 total) per working day late.
- Each assignment and the final exam will be weighted separately so that receiving an average grade on any assignment will give the student the same number of points toward the total course points.
- Statement on academic integrity
 - For AME 513b you may
 - Work with others to find solutions to homework assignments
 - Study with others for the final exam
 - For AME 513b 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 the final exam
 - Violators will be reported to the Office of Committee for Student Judicial Affairs and Community Standards (<http://www.usc.edu/student-affairs/SJACS/>) (for undergraduate students) or the Viterbi Academic Integrity System (for graduate students; see <https://policy.usc.edu/scampus-part-b/>, section 13.10).

Assignment Rubrics

Each assignment will be graded on a 100-point scale, with more emphasis on knowing which equations / physical principles / assumptions / methods are applicable and relevant than on obtaining a specific numerical result. All work must be shown, and lengthy analysis or printouts of computer simulations may be attached as appendices.

Assignment Submission Policy

- Each homework assignment should be on paper in OHE 430N or submitted electronically as a single PDF file via the course D2L DEN website (accessible through <https://courses.uscdcn.net/d2l/login>). Please make sure to append all pages into a single PDF document before submitting.
- Typed solutions are preferred but hand-written solutions are acceptable.

- Ensure that you provide legible and logically-organized solutions that explicitly include all necessary steps and assumptions (if any) made.

Grading Timeline

Assignments will generally be posted on Fridays, due the following Friday, and returned by the following class period.

Suggestions

- Download lectures from website before class
- Most lecture slide packages include
 - Outline
 - Beef
 - Summary
 - References
 - ... so make use of these resources!
- Bringing your laptop or tablet allows you to add notes & download files from course website as necessary
- Download and install Microsoft Office to view the lecture notes and open the embedded Excel spreadsheets - USC has a site license
- Ask questions in class - the goal of the lecture is to maintain a 2-way “Socratic” dialogue on the subject of the lecture

Tentative Course Schedule

“Plans are nothing ... planning is everything” - Dwight D. Eisenhower

	Topics / Activities	Readings and Homework	Deliverable/ Due Dates
Week 1	Introduction and review of AME 513a	Week 1 lecture notes	
Week 2	Extension of AME 513a - chemical kinetics	Week 2 lecture notes	
Week 3	Extension of AME 513a - nonpremixed flames	Week 3 lecture notes HW #1 assigned	
Week 4	Analytical methods in combustion: integral methods	Week 4 lecture notes	HW #1 due
Week 5	Analytical methods in combustion: asymptotic methods	Week 5 lecture notes HW #2 assigned	
Week 6	Aerothermodynamics of flames I: extinction	Week 6 lecture notes HW #7 (white paper) assigned	HW #2 due
Week 7	Aerothermodynamics of flames II: ignition and stability	Week 7 lecture notes HW #3 assigned	
Week 8	Turbulent flames I: premixed flames	Week 8 lecture notes	HW #3 due
Week 9	Turbulent flames II: nonpremixed flames	Week 9 lecture notes HW #4 assigned	
Week 10	Detonations I: structure, propagation rates, initiation and extinction limits	Week 10 lecture notes	HW #4 due
Week 11	Detonations II: applications - accidental explosions, Detonative Propulsion Engines	Week 11 lecture notes HW #5 assigned	
Week 12	Microscale combustion I - heat recirculating reactors	Week 12 lecture notes	HW #5 due
Week 13	Microscale combustion II - power-generating devices	Week 13 lecture notes HW #6 assigned	
Week 14	Emerging technologies and new directions in combustion research - plasma-assisted combustion	Week 14 lecture notes	HW #6 due
Week 15	Emerging technologies and new directions in combustion research - plasma-assisted combustion	Week 15 lecture notes	HW #7 due
Final Exam			Final exam date: consult classes.usc.edu/

White Paper Description

This course considers recent developments and emerging technologies in reacting flows. Thus, it is only reasonable that you try to identify your own “niche” in one of these emerging areas. Prepare a “white paper” (basically a highly compressed, top- level, research proposal), structured as follows (e.g. one paragraph for each bullet item; some bullets may be combined into one paragraph):

- State what your topic is and why it is important
- State what is known about the subject
- Complain about what is lacking in the current state of knowledge
- Explain what you would do that would improve the state of knowledge (i.e. specifically what computer simulation or experiment or analysis you would perform)
- Describe how you would analyze or interpret the data once you had them
- Speculate as to what results you might obtain
- State how these results would advance the state of knowledge of the field
- List your **references**

There is no specific minimum or maximum page limit, but a guideline would be 2 – 3 pages. You may want to include a couple of key figures that would increase the page count. (In the real world white papers are almost never allowed to be more than 2 pages including figures.) Also in a “real” white paper you would also need to include a statement about budget and schedule but you don’t need to do that for this assignment. However, the target level for your white paper should be a project that could be conducted by a small group, e.g., not more than a faculty member, postdoc and 2 graduate students and not a Manhattan Project or Apollo type of proposal.

Project Timeline:

- Week 6: Identify White Paper topic and start background research
- Week 8: Propose White Paper topic to instructor
- Week 10: Receive feedback from instructor on White Paper topic; continue background research
- Week 13: Begin writing White Paper
- Week 15: White paper due

The White Paper will be graded on the following basis:

- Justification of the need for the research 30%
- Originality of the proposed research 30%
- Clarity of the presentation of the proposed concept 40%

Statement on Academic Conduct and Support Systems

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 Part B, Section 11, “Behavior Violating University Standards” policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, policy.usc.edu/scientific-misconduct.

Support Systems:

Student Health Counseling Services - (213) 740-7711 – 24/7 on call
engemannshc.usc.edu/counseling

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call
suicidepreventionlifeline.org

Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-4900 – 24/7 on call
engemannshc.usc.edu/rsvp

Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED) | Title IX - (213) 740-5086
equity.usc.edu, titleix.usc.edu

Information about how to get help or help a survivor of harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants. The university prohibits discrimination or harassment based on the following protected characteristics: race, color, national origin, ancestry, religion, sex, gender, gender identity, gender expression, sexual orientation, age, physical disability, medical condition, mental disability, marital status, pregnancy, veteran status, genetic information, and any other characteristic which may be specified in applicable laws and governmental regulations.

Bias Assessment Response and Support - (213) 740-2421
studentaffairs.usc.edu/bias-assessment-response-support

Avenue to report incidents of bias, hate crimes, and microaggressions for appropriate investigation and response.

The Office of Disability Services and Programs - (213) 740-0776
dsp.usc.edu

Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

USC Support and Advocacy - (213) 821-4710
studentaffairs.usc.edu/ssa

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC - (213) 740-2101

diversity.usc.edu

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call

dps.usc.edu, emergency.usc.edu

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call

dps.usc.edu

Non-emergency assistance or information.