

MAE 4510/5510 Aerospace Propulsion Spring 2018

<http://blackboard.cornell.edu/>

Lectures: 1:25-2:15 PM M/W/F, Thurston 203
4/25/18

Instructor: Prof. E. Fisher, 5-8309, Upson 315, emf4@cornell.edu. If you need to make an appointment for different office hours with Prof. Fisher, send an e-mail *listing several possible meeting times*.

Prof. Fisher's Office Hours, 205 Upson:

Wednesdays 3:30-5 PM

Thursdays 2:30-3:55 PM

TA: X, [Netid](#). Email him if you have questions about your HW or if you are turning in a late HW for partial credit.

TA Office Hours, 205C Upson:

Mondays 4-5 PM

Course Learning Outcomes:

Upon completion of this course, students should be able to:

1. describe and interpret the types, characteristics, and performance measures of combustion engines used in propulsion. (MAE/ABET outcome a);
2. understand the thermodynamic and fluid mechanical principles underlying their performance (ABET a and e);
3. predict how their performance depends on design parameters and operating conditions (MAE/ABET outcomes a and e);

Course Catalog Description: Introduction to air and space propulsion. Emphasis on air-breathing gas-turbines. Chemical rocket propulsion. Brief discussion of electrical propulsion, of ramjets, and of reciprocating engines with propellers. Application of thermodynamic and fluid-mechanical principles to analysis of performance and design, including fuel efficiency and environmental impacts.

Prerequisites: ENGRD 2210 (Thermodynamics, also M&AE 2210) and {M&AE 3230 (Introductory Fluid Mechanics), OR MAE 3050 (Introduction to Aeronautics) or equivalents}

Required text: *Aircraft Propulsion, 2nd Edition*, Saeed Farokhi, John Wiley & Sons, 2014.

Additional recommended references

- o *Mechanics and Thermodynamics of Propulsion*, Philip Hill and Carl Peterson, Addison-Wesley, 2nd Edition, 1992. (Also available in paperback edition. Good for intuition.)
- o *Jet Propulsion*, 3rd Edition, Nicholas Cumpsty and Andrew Heyes, Cambridge University

Press, 2015.

- *The Development of Jet and Turbine Engines*, 4th Edition, Bill Gunston, Haynes Publishing, 2006. (great non-mathematical introduction; describes how and why these engines have changed over the years.)
- *Elements of Propulsion: Gas Turbines and Rockets*, 2nd Edition, Jack D. Mattingly and Keith M. Boyer, AIAA Education Series, 2016.
- *Rocket Propulsion Elements*, 8th Edition, G. P. Sutton and O. Biblarz, John Wiley and Sons, 2010.
- *Fundamentals of Gas Dynamics*, Robert D. Zucker, Matrix Publishers, 1977 (or later editions with Zucker and Biblarz)
- *Introduction to Space Flight*, Francis J. Hale, Prentice-Hall, 1994. (clear, brief intro to orbital mechanics in Ch. 2).

History readings:

- *The Thread of the Silkworm*, Iris Chang, Basic Books, 1995 (biography of Qian Xuesen / Tsien Hsue-shen)
- *Korolev: How One Man Masterminded the Soviet Drive to Beat America to the Moon*, James Harford, John Wiley and Sons, 1997.
- *Von Braun: Dreamer of Space, Engineer of War*, Michael Neufeld, Vintage, Random House, reprinted 2017.

Collaboration and Groups:

You are allowed to discuss homework problems, but you must write up each solution individually, or with members of your group (for group homeworks). You are not allowed to use written or online problem solutions for homework. You are not allowed to share official homework or exam solutions, electronically or otherwise. If you do so, you will be subject to action under Cornell's academic integrity code, <http://cuinfo.cornell.edu/Academic/AIC.html>

If you have any questions, consult Professor Fisher.

Late work

Late homeworks will receive 75% partial credit if received within 1 business day of the due date, and will receive 60% partial credit if received within 3 business days of the due date. No credit will be awarded after that time. For example, homeworks due on Friday will get 75% credit if they are received by 5 PM on the following Monday, and will get 60% credit if they are received by 5 PM on the following Wednesday.

If you are turning in a late homework, please turn it in to the regular homework box. In order to receive credit for the late work, you must e-mail Netid before 4 PM on the day that the homework is turned in.

Exceptions to this policy are limited to documented illness, family emergency, or conflicts with religious observance.

SCHEDULE AND READINGS. Subject to revision!

Week #; start date.	Topics	Tentative Reading Assignments
1 1/24*	Introduction; [Review on your own: thermo, conservation laws, speed of sound]; converging/diverging nozzles; shocks	Read 1.1; Skim 1.2; [review 2.1-2.5 on your own. These sections will not be covered in class.]; read 2.6-2.9
2 1/29	Normal Shocks, Compressible flow	2.11, 2.15, 2.19 [We will return to other Compressible Flow Topics as needed.]
3 2/5	Performance Measures	Chapter 3; maybe also 12.5-12.8
4 2/12	Aero Gas Turbine Cycles	4.1-4.2
5 2/21*	Aero Gas Turbine Cycles	4.3-.44
6 2/26	Aero Gas Turbine Cycles	4.5, 6.23, 12.15
7 3/5	Rocket Engines PRELIM 7:30-9:30 PM Th 3/8/18	12.1-12.11
8 3/12	Rochet Engines	12.1-12.11
9 3/19	Rocket Engines	12.1-12.11
10 3/26	Nozzles and Inlets	Read: 6.1-6.3; 6.5, 6.6 through last full paragraph of p. 335; 6.11-6.13; 6.15-6.16; 2.12 (oblique shocks) Skim: 6.7 through p. 341 and 6.10; 6.14
4/2	SPRING BREAK	
11 4/9	Nozzles and Inlets PRELIM 7:30-9:30 PM Th 4/12/18	Read: 6.17-6.31, 12.14; Skim: 6.32-6.33; 6.35
12 4/16	Turbomachinery	8.1-8.6.3, 8.8
13 4/23	Turbomachinery + combustion	7.1-7.4
14 4/30	combustion	Skim 7.5-7.9
15	Turbines and cooling	10.1-10.4; 12.12

5/7*		
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*This week has only 2 lectures.

Grading scheme and further information about assignments

	4510	5510
PRELIMS	42%	42% for 4510; 36.75% for 5510 (including take-homes for first prelit)
FINAL EXAM	32%	24%
HOMEWORKS	25%	25% (including extra problems)
PROJECT	N/A	13.25%
COMPLETING COURSE EVALS	1%	1%

Commented [REV1]: Discovered 5/23 that this really should be 37.75%

Up to 2% boost in final numerical grade may be awarded at the instructor's discretion, based on participation, effort, improvement, "good citizenship."

If you find an error in the textbook (verified by Prof. Fisher) and if you are the first person to e-mail Prof. Fisher about the error, you will receive a small amount of extra credit. Be sure to check the errata page before submitting your finding.

Homeworks are to be turned in by 5 PM, using the homework box on the second floor of Upson Hall (near 205 Upson). Most HW will be due on Thursdays or Fridays.

There will be two prelims: Thursday 3/8/2018 and Thursday 4/12/18, both in Phillips 101. MAE 5510 students have take-home questions in addition to the evening prelit, and have a final project due on the last day of class, in addition to the final exam. The final will be held 2-4:30 PM on Tuesday May 15.