ASTE 470 Fall 2011 Schedule

Spacecraft Propulsion

Wednesday 6:30 - 9:10 P.M. **OHE100 Studio B** **3 Units**

Week	Date	Subject	Notes	HW due
1	Aug. 24	Organization of the class. History of space exploration. Types of rockets. Units. Definitions	1, 2	
2	Aug. 31	Orbital mechanics. Basic orbits, Hohmann transfer, maneuvers, ΔV. Launch sites.	2, 3	*
3	Sep. 7	Thrust. Specific impulse. Rocket equation. Staging. Thermodynamics of fluid flow.	3, 4	1
4	Sep. 14	Combustion. Chemical equilibrium.	4	2
5	Sep. 21	One-dimensional flow.	4, 5	3
6	Sep. 28	Flow in nozzles. Non-ideal flow. Shocks. Boundary layer.	5	4
7	Oct. 5	Ideal rocket, thrust coefficient, characteristic velocity. Nozzle types.	6	5
8	Oct. 12	Rocket heat transfer. Liquid rocket systems. Review	7	6
9	Oct. 19	Midterm Exam in class on campus.		
10	Oct. 26	Starting and ignition. Processes in combustion chamber. Injection. Liquid propellants. Feed systems	8	7
11	Nov. 2	Solid rocket. Burn rate, erosive burning. Grain design.	9	8
12	Nov. 9	Solid propellants.	9,10	9
13	Nov. 16	Hybrid rockets. Thrust vector control.	11	10
14	Nov. 23	Power sources. Electric propulsion.	12	11
15	Nov. 30	Electric propulsion. Advanced propulsion	13	12

Dec. 7 Final Exam 7:00 - 9:00 PM in class on campus

* Class survey, email addresses, and obtain additional needed materials for unfamiliar topics.

Instructor:

Keith Goodfellow

USC: RRB 218 (Prof. Erwin's office), (213) 740-5358, Fax (213) 740-7774, Office hours; before or after class. I'm usually on campus by 4:30 or 5:00. Sometimes the RRB outside door is locked around 5:00 P.M. I will try to block it open. If you find it locked, ring the bell, and someone will let you in.

email: keith.goodfellow@usc.edu

Email: Communication by email is welcome and encouraged. It is a reliable and easy method for communicating with distant folks (students and instructor), as well as providing a saved transcript. A class email list will be established for sending out information between lectures. Sometimes there are errors in the homework questions, missing information, or several students may ask the same clarification question. In those cases I will email everyone corrections and/or hints. You may have as many email addresses on the list as you would like (home, work, etc.). The addresses will not be shared with everyone else.

TA: TBD

This class will have a teaching assistant (sometimes 2) that will grade the homework and be available for questions and homework help. The office hours and contact information for the TA will typically be set up sometime in the first two weeks of class.

Prerequisite: senior or graduate standing. This course covers material from a variety of technical disciplines. There may be areas you have never seen before. We will briefly **review** the material in each area. Everything that you will need to do the homework will be given. If you are seeing this material for the first time, you may need additional resources. You are encouraged to obtain undergraduate level materials (notes from friends, textbooks, etc.) to use as references, additional information, and for additional example problems. Graduate level materials are often too detailed and you may find them confusing. In particular, if you have never covered compressible gas dynamics (supersonic flow in nozzles) or heat transfer before, you should get some additional materials. If you need help locating material, let us know.

Required Text:

No textbook is required. Optional books you will find helpful are listed below.

The course notes, that are mandatory for the course, are available on the class DEN website.

Additional/Optional Reading:

If you plan to work in the field of propulsion or an area closely related to it, then these are excellent references to have. Some students find the additional material helpful for this class and some do not.

P. Hill and C. Peterson, Mechanics and Thermodynamics of Propulsion 2nd edition, Addison-Wesley Publishing, 1992, ISBN 0-201-14659-2

An excellent book covering the fundamentals of propulsion. It covers both rockets and air-breathing. Not as much details on rockets as the following 2 textbooks, but it is a better textbook for fundamentals. This was the required textbook for several years.

G. Sutton and O. Biblarz, Rocket Propulsion Elements 8th edition, John Wiley & Sons, 2010, ISBN 978-0-470-08024-5
An excellent book for the fundamentals of variety of chemical rocket elements (propellants, feed system layouts, thrust vectoring, etc.). The 7th and 8th editions are much better than the previous editions.

R. W. Humble, G. N. Henry and W. J. Larson, Space Propulsion Analysis and Design, McGraw-Hill Inc, 1995, ISBN 0-070-31320-2.
This book focuses more on the design methodologies of spacecraft propulsion systems and missions rather than on the fundamentals. It covers chemical, electric and nuclear systems.

Other books from Prof. Gruntman's list of recommended books: See http://astronauticsnow.com/AstroBooks/index.html

Other Books of Interest:

R. Jahn, Physics of Electric Propulsion, Dover, 1996, ISBN 0-486-45040-6. Originally published in 1968 by McGraw-Hill reprinted by Dover. You can't beat the $20 cost.
THE standard book on electric propulsion. Used as a textbook for ASTE 572, Advanced Spacecraft Propulsion.

M. Gruntman, Blazing the Trail, The early History of Spacecraft and Rocketry, AIAA, 2004, ISBN 1-56347-705-X.
An excellent book on the history of the field. Unique in its coverage of both the US and Soviet programs

J. Dewar, To the End of the Solar System, The Story of the Nuclear Rocket, The University Press of Kentucky, 2004, ISBN 0-8131-2267-8.
An excellent book covering the history of the nuclear thermal rocket program. Both the technology and the politics.

USC Distance Education Network (DEN). The DEN home page is: http://den.usc.edu/ Our class site will contain the notes for each lecture, the homework assignments, the homework and exam solutions, and the annotated lecture notes from each class. The class web site is available to both on-campus and off-campus students. Everyone should have an account. Talk to the DEN folks about problems with or questions about DEN.

Hand-Outs. The handouts will consist of homework assignments and notes that are essential and mandatory to the course. Course notes, homework assignments and homework solutions will be posted on the DEN ASTE 470 web site. The notes we will be using for each lecture will be posted prior to class. Please bring a copy to class. At the end of each lecture I will have the DEN scan and post the written lecture notes. You can download these notes if you miss anything during the lecture. They are usually posted the day after our class.

Discussion Forum on DEN site. The DEN ASTE 470 web site has discussion forums in the areas of class lectures, homework and areas of interest. This is a good place to ask clarification questions on the lectures or homework that would be of interest to everyone. Please do not post solutions and keep it professional. Violators will be removed from the forum. Areas of Interest could be anything you think the rest of the class would be interested in or questions you may have.

Class Procedure: Teaching will be done directly from the notes and at the board. It is advisable to review the appropriate material before the lecture and bring the appropriate notes to class.

Homework: As scheduled. One homework score (30 points) will be dropped for a total of 11 recorded scores. Problem set 11 is typically worth 60 points (counts as 2). The homework is worth 30% of the total grade and the exam questions are often based on the homework. Therefore, if you fail to do the homework, it is unlikely you will receive a good grade for the course. Extra credit problems may be given at times. No other "special" problems, projects, or extra work will be given.

Students are encouraged to work together and share ideas but each student must turn in their own work. Plagiarism, either from another's work or from previous homework solutions will not be allowed and will result in loss of credit for the assignment. Repeat offenders may be dropped from the course and expelled from the department.

If you are a distant student and would like to know if there are others in your region, let me know. I will provide a local contact list for anyone wanting it. Your contact information will not be shared to others without your written approval (email).

Attendance: It's up to you. We won't be keeping track, but you will be missing a significant portion of the material.

Religious Holy Days: Please make arrangements in advance to make up work missed on those days.

Exams: One midterm: Wednesday, October 19, in class, **on campus,** usually 90 minutes.
Final exam: Wednesday, December 7, 7:00-9:00 P.M. in class, **on campus**
Make-up exams will only be given for special conditions (illness, death in the family, etc.) or by prior arrangement for job related issues. The make-up exam will be harder than the regular exam.

Grading:

Homework	= 30%
Midterm	= 30%
Final	= 40%

Late homework can be submitted one week after the due date and will be graded and reduced by a 50% factor. No homework will be accepted after the solutions have been posted. If you have grading questions please call of see the TA first and then contact the instructor if there is still a problem.

Questions: Discussion is always welcome and encouraged on all aspects of astronautics and space explorations well as on the topic at hand. (We do not guarantee immediate answers on the abstract questions but sometimes will need to adjourn the discussion until we are better informed) For the benefit of remote students, on-campus students should speak loudly and clearly in order that everyone can hear their questions. Off-campus students are encouraged to phone in questions at any time. The studio phone number will be displayed at the beginning of each lecture.

