AE435 Course Description

AE 435 Electric Propulsion **Spring Semester, 2015**

29965 Lect.-Disc. 3:30 AM – 4:50 PM Tues-Thurs 103 Talbot

Professor: Rodney L. Burton, 319A Talbot Lab, 217-621-2076 rburton@illinois.edu

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Office Hours and Location M 1-2:30 and W 11-12:30, 225A Talbot

Course Description Electric propulsion is now the preferred propulsion method for unmanned spacecraft. The course covers: elements of electrically-driven rocket propulsion for applications from low earth orbit to the outer planets; thruster system performance, power requirements and selection for space missions; physics of ionizing and heating propellants for electrothermal, electrostatic and electromagnetic acceleration; characteristics of Resistojet, Arcjet, Magnetoplasmadynamic, Pulsed Plasma, Hall, and Electrostatic thrusters.

Course Topics

Topic	Title	Lectures
1.	Introduction, General Definition of EP; Design considerations--Why EP? Space Missions. Satellites (NSSK, maneuver, orbit transfer). Deep space.	1
2.	Simple systems. Single string, propellants (liq.,gas,solid,gel), propellant handling, system mass.	
3.	Propellant mass. Rocket equation, mission ΔV, Edelbaum eq., mission opt.	1
4.	System mass optimization.	1
5.	Thruster types. Seven types. Performance characteristics, main advantages/disadvantages, usefulness, efficiency, sources of loss.	1
6.	Acceleration mechanisms. 3 main types of thrusters and subcategories, circuits, power , voltage, EM energy addition (electron heating)	2
7.	Very basic Electromagnetic Theory, force eqs, charge conserv. **¶B/¶t**	2
8.	Cold gas heating. Particle view, ionization mech., Saha Eq., enthalpy	3
9.	Particle Collisions in an Ionized Gas	2
10.	Electrical Conductivity, transport, Ohm's Law for plasma	2
11.	Energy processes, electrons to heavy particles.	1
12.	DC Electrothermal Acceleration; resistojets, arcjets	2
	"CubeSat Propulsion", lecture by representative from industry	1
13.	Electromagnetic Acceleration; MPD thruster and railgun	2
14.	Pulsed Devices; Teflon PPT, 2-Stream Model, pulsed arcjet	2
15.	Hall thrusters, the SPT, Hall effect, relation to ion thrusters	2
16.	Electrostatic Acceleration; ion thrusters, NSTAR, NEXT	2
17.	Summary: Tuesday, TBD	1
	Hour exam, TBD	1
		29

Grading [UG and Grad grades are on a separate scale; grad exams are longer]

Homework [**HW is required**]	55%	[7-9 HWs; Th Class-4 PM Th]
Midterm Hour Exam	15%	March XX
Final Exam	30%	May 8-15, 1:30 PM
	100%	
Extra Credit Paper [1 HW equiv.]	+7%	April XX

Textbook: **R. G. Jahn**, Physics of Electric Propulsion, McGraw Hill, 1968.
(Available online as Dover paperback)

References:

J. D. Jackson, Classical Electrodynamics, 2nd ed., John Wiley, 1975.
Hill & Peterson, Mechanics and Thermo. of Propulsion, Addison-Wesley, 1965.
Spitzer, Physics of Fully Ionized Gases, 2nd ed., Interscience, 1962.
Sutton & Sherman, Engineering Magnetohydrodynamics, McGraw-Hill, 1965
Anderson, Modern Compressible Flow, McGraw-Hill, 1990

Makeup class: TBD

PRELIMINARY

AE 435 Homework Schedule--2013

Date		Handed out	Due
January 15		Class	
17		**HW 1**	**1/25**
22		Class	
24		**HW 2--HW 1 due tomorrow**	**2/1**
29		**Extra Credit Start**	**4/22**
31		**Work on Extra Credit--HW 2 due tomorrow**	
February 5		Class	
7		**HW 3**	**2/15**
12		Class	
14		**HW 4 ♥ -- HW 3 due tomorrow**	**2/22**
19		Class	
21		**Extra Credit--HW 4 due tomorrow**	
26		Class	
28		**Study for exam**	
March 4		**MID TERM EXAM**	
6		**HW 5**	**3/14**
11		Class	
13		**HW 6--HW 5 due tomorrow**	**3/28**
18		**Spring Break**	
20		**Spring Break**	
25		Class	
27		**HW 7--HW 6 due tomorrow**	**4/4**
April 1		Class	
3		**Class--HW 7 due tomorrow**	
8		Class	
10		**HW 8**	**4/18**
15		Class	
17		**Class--HW 8 due tomorrow**	
22		**Extra Credit due today**	
24		Class	
29		**Course Summary**	
May 9		**FINAL EXAM**	