

January 16, 2024

## Electric Space Propulsion (AE435) Syllabus

**Pre-Requisite:** AE 312 or ME 410, PHYS 212, and ECE 205

**Instructor:** Dr. Christopher Lyne, email: [clyne2@illinois.edu](mailto:clyne2@illinois.edu)

**Class Time:** T Th 11-12:20PM, 101 Transportation Building

**Office hours:** Tuesday 1-2PM – in Talbot Lab 319N, and on ZOOM

Meeting URL: <https://illinois.zoom.us/j/7878752607?pwd=UXVQa1hnRWtYVzM5bDdTYWxWTldRdz09>

Meeting ID: 787 875 2607

Password: 444559

**Course Assistant:** Myles Gong, [mylesyg2@illinois.edu](mailto:mylesyg2@illinois.edu)

*This is a Note-Intensive Class! Much of the material is given only in lecture notes. YOU are responsible for attending class and taking notes. Course notes are posted on CANVAS, both PDF and PPT files. The text is important but only supplementary to the notes!*

**Required Text:** Jahn, Robert, Physics of Electric Propulsion, Dover Pub., NY, 2006

### Helpful References:

Goebel & Katz, Fundamentals of Electric Propulsion: Ion and Hall Thrusters, John Wiley & Sons, 2008.

Chen, F.F., Introduction to Plasma Physics and Controlled Fusion, Plenum Press, 1984, Ch. 1-3.

Spitzer, Physics of Fully Ionized Gases, 2nd ed., Interscience, 1962.

Sutton & Sherman, Engineering Magnetohydrodynamics, McGraw-Hill, 1965

Vincenti & Kruger, Introduction to Physical Gas Dynamics, Krieger Publishing, 1965, Ch. 1-2

Purcell, E.M. and Morin, D.J., Electricity and Magnetism, Cambridge Univ. Press, 2014, Ch. 1-3.

J. D. Jackson, Classical Electrodynamics, 2nd ed., John Wiley, 1975.

Hill & Peterson, Mechanics and Thermodynamics of Propulsion, Addison-Wesley, 1965.

### Goals: The goals of this class are to:

1. Cover the basics of electromagnetism, gas kinetic theory, and plasma physics.
2. Familiarize you with existing and proposed electric propulsion devices.
3. Prepare you for industrial or graduate work in EP.

### Objectives: By the end of the course you should be able to:

1. Demonstrate a working knowledge of electrostatics, electromagnetics, and charged particle motion.
2. Demonstrate a fundamental understanding of Debye lengths, cross-sections, velocity distributions, and adiabatic invariants.
3. Estimate thrust, specific impulse, and jet power given thruster type and operating conditions.
4. Choose appropriate advanced propulsion devices for a specified mission.

## Grading:

Letter Grade	Score
A	93 and above
A-	90-93
B+	87-90
B	83-87
B-	80-83
C+	77-80
C	73-77
C-	70-73
D	60-70
F	<60

Item	Due Date	Time	Weight
HOMEWORK	Thursdays	11 AM	40%
MIDTERM	5-Mar	In-Class	25%
FINAL EXAM	9-May	7-10PM	35%

## Topics: The course outline is as follows:

Week	Topic	Reading
15-Jan	Introduction, General Definition of EP. Why EP?	
22-Jan	Electricity, Magnetism, Charged Particles	Jahn Ch. 2, Purcell Ch. 1-3, Chen Ch. 1-3, Jahn Ch. 5
29-Jan	Electricity, Magnetism, Charged Particles	Jahn Ch. 2, Purcell Ch. 1-3, Chen Ch. 1-3, Jahn Ch. 5
5-Feb	Kinetic Theory, Ionization of Gases	V&K Ch. 1-2, Jahn Ch. 3-4
12-Feb	Kinetic Theory, Ionization of Gases	V&K Ch. 1-2, Jahn Ch. 3-4
19-Feb	Kinetic Theory, Ionization of Gases	V&K Ch. 1-2, Jahn Ch. 3-4
26-Feb	Kinetic Theory, Ionization of Gases	V&K Ch. 1-2, Jahn Ch. 3-4
4-Mar	MIDTERM EXAM March 5, 2024 In Class	
11-Mar	SPRING BREAK	
18-Mar	Electrothermal Propulsion	Jahn Ch. 6
25-Mar	Electrothermal Propulsion	Jahn Ch. 6
1-Apr	Electromagnetic Propulsion	Jahn Ch. 8
8-Apr	Electromagnetic Propulsion	Jahn Ch. 8
15-Apr	Electrostatic Propulsion - Ion Thruster	Jahn Ch. 7, Goebel Katz Ch. 4 & 5
22-Apr	Electrostatic Propulsion - Hall Thruster	Jahn Ch. 7, Goebel Katz Ch. 7
29-Apr	Electrostatic Propulsion - Electropray	Notes
	FINAL EXAM May 9th, 2024 Location TBD 7-10PM	

These dates are subject to change, except for the final exam. Changes will be communicated via email and in class.

## Notes:

- There are NO make-up exams. But if you have a conflict, notify me early and ahead of time and we can work something out.
- The final exam is cumulative (it covers everything).
- Homework will be due on Thursday at the beginning of class. No Late Homework accepted.
- Homework is to be turned in through Gradescope. Uploads after 11AM beginning of class will not be accepted.

## 4 Credit Hour Students:

Some students may have registered for 4 hours of credit for this course. Those students enrolled in this course for 4 hours of credit will complete a substantial extra assignment that will count as part of their homework grade. Details on that assignment will be released within the first two weeks of classes starting.

**Communication:**

Please check your email daily. I also plan to use CANVAS to post HW, handouts, announcements, etc.  
<https://canvas.illinois.edu/>

**Academic Dishonesty:** Violations of academic integrity are unacceptable. Review the University of Illinois student code section on Academic Integrity and Procedure for more information.

[http://studentcode.illinois.edu/article1\\_part4\\_1-402.html](http://studentcode.illinois.edu/article1_part4_1-402.html)

**Emergency Response:**

Emergency response recommendations are provided by the University of Illinois Police Department. Review those procedures at: <http://police.illinois.edu/safe>

- <http://police.illinois.edu/safe> for more information on how to prepare for emergencies, including how to run, hide or fight and building floor plans that can show you safe areas.
- <http://emergency.illinois.edu> to sign up for Illini-Alert text messages.
- Follow the University of Illinois Police Department on Twitter and Facebook to get regular updates about campus safety

**SUMMARY of Important E-Platforms for this Course**

- ZOOM - <https://zoom.us/> - is always available for all class office hours
- Gradescope - <https://www.gradescope.com/> - for downloading and uploading homework and exams, and tracking your grades and performance in the course
- CANVAS - <https://canvas.illinois.edu> - for announcements and course handouts, and homework and exam solutions
- Media Space – <https://mediaspace.illinois.edu/channel/channelid/329302142> - lecture videos