Electric Space Propulsion (AE435)
Spring 2025 Syllabus

Pre-Requisite: AE 312 or ME 410, PHYS 212, and ECE 205
Instructor: J.L. Rovey, 302B Talbot Lab, Phone: 217-300-7092, email: rovey@illinois.edu
Class Time: TTh 11-12:20PM, 101 Transportation Bldg
Office hours: T 9:30-10:30AM – in my office, and on ZOOM

Phone one-tap: US: +13126266799,,87930186816# or +12678310333,,87930186816#

Meeting URL: https://illinois.zoom.us/j/87930186816?pwd=1dvIDTCpMYoFBvwNRlnXtj1FgbHepH.1
Meeting ID: 879 3018 6816
Password: 596065

Teaching Assistant: Toyofumi Yamauchi, ty20@illinois.edu
Office hours: Monday 5-7PM on ZOOM, and Thursday 12:30-2:30PM on ZOOM and in person at Desk
#41 in Gradstudent Office Space:

Phone one-tap: US: +13126266799,,87930186816# or +12678310333,,87930186816#

Meeting URL: https://illinois.zoom.us/j/87930186816?pwd=1dvIDTCpMYoFBvwNRlnXtj1FgbHepH.1
Meeting ID: 879 3018 6816
Password: 596065

Course Assistant: Dominick Long – dalong3@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, gaskinetic 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	11AM	40%
MIDTERM	13-Mar	In-Class	25%
FINAL EXAM	15-May	7-10PM	35%

Topics: The course outline is as follows:

Week	Topic	Reading
20-Jan	Introduction, General Definition of EP. Why EP?	
27-Jan	Electricity, Magnetism, Charged Particles	Jahn Ch. 2, Purcell Ch. 1-3, Chen Ch. 1-3, Jahn Ch. 5
3-Feb	Electricity, Magnetism, Charged Particles	Jahn Ch. 2, Purcell Ch. 1-3, Chen Ch. 1-3, Jahn Ch. 5
10-Feb	Conductivity	V&K Ch. 1-2, Jahn Ch. 5
17-Feb	Kinetic Theory	V&K Ch. 1-2
24-Feb	Kinetic Theory	V&K Ch. 1-2
3-Mar	Collisions	V&K Ch. 1-2, Jahn Ch. 4
10-Mar	Thermal Ionization of Gases	V&K Ch. 1-2, Jahn Ch. 3
	MIDTERM EXAM March 13, 2024 In Class	
17-Mar	SPRING BREAK	
24-Mar	Electrothermal Propulsion	Jahn Ch. 6
31-Mar	Electrothermal Propulsion	Jahn Ch. 6
7-Apr	Electromagnetic Propulsion	Jahn Ch. 8
14-Apr	Electromagnetic Propulsion	Jahn Ch. 8
21-Apr	Electrostatic Propulsion - Ion Thruster	Jahn Ch. 7, Goebel Katz Ch. 4 & 5
28-Apr	Electrostatic Propulsion - Hall Thruster	Jahn Ch. 7, Goebel Katz Ch. 7
5-May	Electrostatic Propulsion - Electrospray	Notes
12-May	FINAL EXAM May 15th, 2024 Location TBD 7-10PM	

- The final exam is cumulative (it covers everything).
- Homework will be due on Thursday at the beginning of class.
- Homework is to be turned in through Gradescope.

Policies:
- I do not accept late homework.
- I do not give extensions on homework.
- I do not replace uploaded homework. If you submit the wrong homework solution to Gradescope, and then email me the correct homework solution, we grade the homework in Gradescope, not the emailed homework.
- I do not transfer homework from CANVAS to Gradescope. If you submit the homework solution to CANVAS and not Gradescope, we do not grade CANVAS homework submissions because we only grade homework that is in Gradescope.
- I do not proctor exams for students with accommodations. If you have accommodations, please schedule your exams with TAC. If you cannot get an appointment with TAC (e.g., all TAC final exam appointments are filled), you will need to take an Incomplete grade and complete the final exam whenever the next TAC appointment is available. Neither the TA nor I proctor these exams.
- I do not proctor mid-term exams for students in the ONC section of the course. If you are on-campus, but taking this class remotely, you are responsible for securing proctoring services for your

mid-term exam. For example, with the UIUC Testing Center. For the final exam, there will be an alternative test date determined by the registrar.

- Please submit regrade requests for homework and exams through Gradescope. Regrade requests for a particular homework or exam **must be submitted within 2 weeks** of the grade being released. For the final exam, regrade requests **must be submitted within 24 hours** of the grade being released.
- I do not offer extra credit.
- If you have a religious observance conflict, you must notify me **at least one week in advance of (i.e., before)** the conflict.
- If you have a conflict with an exam date/time, you must notify me **at least one week in advance of (i.e., before)** the exam.
- I encourage you to use the CANVAS Discussion Board to post/ask questions about course content. Discussion Board questions are answered at least once a day. Emailed questions to me or the TA are typically posted to and answered on the discussion board by me or the TA.

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 homework assignment. This assignment will be released approximately and at least 4 weeks before the end of the course and will be due at the Final Exam. It will be turned in on GradeScope before the Final Exam. This extra assignment is incorporated into your homework grade.

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

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. **Entry Code: Z3X7K8**
- CANVAS - https://canvas.illinois.edu - for announcements and course handouts, and homework and exam solutions
- Media Space – https://mediaspace.illinois.edu/channel/channelid/366621532 - lecture videos