THE DEPARTMENT OF AERONAUTICS AND ASTRONAUTICS

AA 405 INTRODUCTION TO AEROSPACE PLASMAS

AUTUMN QUARTER

CREDITS AND CONTACT HOURS: 3 Credits, Three 50-minute lectures per week**.**

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TEXTBOOK: Physics of Space Plasmas, G. K. Parks, Westview Press, 2003.
Introduction to Plasma Physics and Controlled Fusion, F. F. Chen, Springer, 1984.

SUPPLEMENTAL MATERIALS: Classical Electrodynamics, J. D. Jackson, Wiley, 1998.
Electromagnetic Fields and Waves, P. Lorrain and D. R. Corson, W.H.Freeman & Co Ltd, 1970.

CATALOG DATA: INTRODUCTION TO AEROSPACE PLASMAS, Selective Elective
Development of introductory electromagnetic theory including Lorentz force and Maxwell's equations. Plasma description. Single particle motions and drifts in magnetic and electric fields. Derivation of plasma fluid model. Introduction to plasma waves. Applications to electric propulsion, magnetic confinement, and plasmas in space and Earth's outer atmosphere. Prerequisite: PHYS 123; MATH 324.

PREREQUISITES BY TOPIC:

1) Working knowledge of vector algebra
2) Some electromagnetism theory is helpful but not required

OUTCOMES:

1) Students will be able to calculate the electric and magnetic fields for a given electrode and current geometry.
2) Students will be able to predict charged particle motion in the presence of electric and magnetic fields.
3) Students will be able to apply the single fluid magnetohydrodynamic plasma model to solve plasma physics problems.
4) Students will be able to perform scoping designs of mission specific electric plasma thrusters.
5) Students will be able to explain the basic principles of magnetic confinement fusion.

RELATIONSHIP TO STUDENT OUTCOMES:

a) An ability to apply knowledge of mathematics, science, and engineering
b) An ability to design and conduct experiments, as well as to analyze and interpret data
e) An ability to identify, formulate, and solve engineering problems solutions in a global and societal context

i) A recognition of the need for, and an ability to engage in life-long learning.
k An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:

1) Overview of space and laboratory plasma applications; quick review of electromagnetic theory
2) Basic plasma properties: Lorentz force equation; Debye shielding; magnetic fields and mapping of field lines
3) Single particle trajectories: convective drift motions, curvature and gradient drifts
4) Plasmas as fluids: derivation of the Magnetohydrodynamics (MHD) equations; frozen-in-fields; application to magnetospheric structure; laboratory equilibrium
5) Waves in plasmas: phase speeds, group speeds, polarization of various waves including Langmuir waves, sound waves, Alfen waves