New Jersey Institute of Technology

PHYS 444 – FLUID AND PLASMA DYNAMICS (3-0-3)

Spring 2018, Sect 002, MW 8:30-9:55 AM, FMH 310

Topics: Introduces the basics of [fluid and] plasma physics. Covers the following plasma parameters, single particle motions, plasma as fluid, waves, diffusion and resistivity, equilibrium and instability, kinetic theory, nonlinear effects. Applications in three areas: controlled fusion, astrophysics, and interaction between light and plasma.

Learning Outcomes and Objectives:

1. Demonstrate the use of the Navier-Stokes equations in scale-analysis.
2. Demonstrate the use of the Navier-Stokes equations for the solution of sound waves, surface gravity waves, and internal gravity waves.
3. Demonstrate use of the Bernoulli equation for steady flows.
4. Demonstrate knowledge of convective and dynamic instabilities
5. Demonstrate knowledge of magnetohydrodyamic [MHD] equations
6. Demonstrate the solution of Alven waves from MHD equations
7. Demonstrate knowledge invarients associated with dipole magnetic fields.
8. Demonstrate knowledge of "cutting-edge" research topics in fluids and plasmas.

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Prerequisites: Phys 234 or Phys 234H or Phys 231H and Math 222 or Math 222H, all with C or better.

Required Texts: None.

Course Requirements and Grading Policy:

Homework: 30%

Homework is given every other week and is considered an important part of the class. The homework usually consists of reading the text, short answer questions, and numerous mathematical calculations. Students *are encouraged to work together* on the homework problems, though each student is responsible for handing in an *individual* homework set. No late homeworks are allowed to be turned in without the prior consent of the instructor.

2 Exams (1 mid-term and 1 final, worth 15% each and 25%, respectively): 40%

The purpose of the exams is to test the *individual* student's progress in the class. Exams are closed book/notes, but the student is allowed to bring in one 8.5x11 inch sheet of notes for each exam. Later exams can make use of previous note sheets (i.e., the note sheets are cumulative). Exams will be announced ahead of time. (Missed Exams: Students who miss an exam will receive a score of zero for that exam unless they present a valid excuse within 7 days of the exam.)

Semester Project: 20%

The students will write a 5-page paper [of text, on 8.5"x11" paper, 10 pt font, 3-5 suitable figures, double spaced] on 1-topic of their choice THAT INVOLVES FLUID AND/OR PLASMA MECHANICS. Students must include references and figures as needed, though reference pages do not count towards the 5-page limit. All topics must be pre-approved by the instructor.

Class participation 10%

Attendance at lecture is expected.

THE NJIT HONOR CODE WILL BE STRICTLY ENFORCED AND ANY VIOLATIONS WILL BE BROUGHT TO THE IMMEDIATE ATTENTION OF THE DEPARTMENTT HEAD AND DEAN OF STUDENTS.

Week	Date	Topic
1	Jan 14	Intro. to Class
2	Jan 21	N-S and Kinematics
3	Jan 28	Boussinesq and Bernoulli
4	Feb 4	Surface gravity waves
5	Feb 11	Internal gravity waves
6	Feb 18	Geophysical Fluid Dynamics
7	Feb 25	**MIDTERM + SEMESTER PROJECT TOPICS DUE**
8	Mar 4	Instability
9	Mar 11	**SPRING BREAK**
10	Mar 18	MHD and Ideal MDH
11	Mar 25	Ideal MHD waves
12	Apr 1	MHD waves and turbulence
13	Apr 8	Magnetic Dipole topology and Adiabatic Invariants
14	Apr 15	Reconnection
15	Apr 22	Research in Progress in Hydrodynamic and Magneto-Hydrodynamic Physics
16	Apr 29	Final Class