AME60630: MICROPARTICLE DYNAMICS

FALL 2010

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COURSE STRUCTURE:

The requirements for this course are the successful completion of a course in fluid mechanics and the ability to write and run computer programs. Homework problems typically will require writing and running a computer program to calculate and plot results. The course will be taught at the senior/first-year graduate level. The fundamentals behind many new and challenging problems related to multiphase flows will be covered.

TOPICS:

This course involves the study of the behavior of nanometer-to-millimeter sized solid particles or liquid droplets (aerosols) undergoing motion in a gas or in a vacuum. The fundamental laws that govern each topic will be presented, followed by the application of these laws to formulate and to obtain analytical and numerical solutions, as illustrated through worked examples. The order of topics follows the progression from the molecular to the transition to the continuum flow regimes. Topics include but are not limited to:

- Introductory concepts (regimes, coupling, collision cross-section, mean free path, ...)
- Molecular basis of various gas laws (equations of state)
- Kinetic theory of gases (MB velocity distribution, molecular basis of macroscopic properties)
- Ions, electrons, plasmas in electric fields; aerosol charging
- Molecular and aerosol diffusion
- The Bassett-Boussinesq-Oseen equation; aerosol and gas momenta equations
- Modeling aerosol transport in various force fields (gravity, E, B, temperature gradient including evaporation, concentration gradient, laminar and turbulent flows, ...)
- Aerosol interaction with surfaces (adhesion, impact, detachment)
- Aerosol growth and interaction with other aerosols (nucleation, coagulation, size distributions and their evolution, …)

STUDENT ASSIGNMENTS AND RESPONSIBILITIES:

- Every class:

  Read the provided material before class such that you can effectively participate in discussion and ask questions during class.

- Each week (due on most Mondays – see course calendar):

  [1] Turn in marked (use red) copy of the previous week's material. Note any errors; mark any comments/changes to make the material more

understandable. Note in the text where your example is to be inserted. Your marked copy will be returned to you on Wednesday of the same week.

[2] Prepare one well-developed and proof-read example problem to be inserted into the text material. This includes the problem subject, statement, and full solution. This must be written in the prescribed LaTeX format. Submit a paper copy to me in class along with your marked notes from [1] AND also email the .tex file to the TA. Title your problem as exprobXlastname.tex (for example, ExProb3dunn.tex, where X denotes the assignment number).

- Sometimes, I will give you a home problem that requires you to write a small program to solve the problem and plots its results. This will help you to develop a larger code to solve many aerosol problems.

EXAMINATIONS:

- There will be a mid-term and a final exam. Both exams will be 'take-home' and require you to solve problems using the programs that you have developed. Some of the problems may be chosen from your example problems.