**ME 437 PARTICLE TRANSPORT, DEPOSITION AND REMOVAL-I**
**FALL 2002**

**INSTRUCTOR:** G. Ahmadi, Room 267 CAMP (268-2322)
Office Hours: MW 1:30 - 3:15 p.m., T 1:00 - 2:30 p.m.
**TEXT:** None

**COURSE WEB SITE:** http://www.clarkson.edu/fluidflow/courses/me437/

**Course Objectives**

1. To provide a fundamental understanding of aerosol transport and removal in laminar flows.
2. To provide a fundamental understanding of particles adhesion and removal from surfaces
3. To familiarize the students with the computational modeling of particle resuspension in laminar flows.
4. To familiarize the students with the industrial applications of aerosols.

**Course Learning Outcomes**

**Objective 1:**
- Students will be able to formulate and solve aerosol transport and deposition in laminar flows.

**Objective 2:**
- Students will be able to analyze particle adhesion and removal of micro- and nano-particles.

**Objective 3:**
- Students will become familiar with computational fluid mechanics and particle trajectory analysis procedures.
- Students will demonstrate using the FLUENT Code for solving aerosol transport in laminar flows.
- Students will become familiar with the experimental procedure for particle adhesion and removal analysis.

**Objective 4:**
- Students will become familiar with the microcontamination problems in microelectronic and imaging industries.
- Students will become familiar with the surface cleaning including ultrasonic cleaning.

**COURSE OUTLINE**

**REVIEW Of VISCOUS FLOWS**
! Navier-Stokes Equation
! Simple Flows

! Creeping Flows
! Drag on Spherical Particles

**REVIEW OF COMPUTATIONAL FLUID MECHANICS**

! Finite Difference and Finite Volume Methods
! Introduction to Fluent Code

**AEROSOLS**

! Introduction to Aerosols
! Hydrodynamic Forces (Drag, Lift)
! Brownian Motions
! Convective Diffusion
! Aerosol Kinetics
! Particle Deposition Mechanisms
! Gravitational Sedimentation
! Aerosol Coagulation

**PARTICLE ADHESION**

! JKR and other Adhesion Models
! Particle Removal
! Effects of Charge and Humidity

**SIMULATION METHODS**

! Laminar Flow Simulation
! Spherical Particles in Laminar Flows
! Brownian Motion of Nanoparticles
! Spherical Particles Resuspension

**EXPERIMENTAL TECHNIQUES**

! Particle Adhesion Measurement
! Particle Removal
! Surface Cleaning
! Laser Surface Scanner

**APPLICATIONS**

! Microcontamination Control
! Surface Cleaning
! Clean Room and Process Equipment
! Ultrasonic and Megasonic Cleaning

**EVALUATION METHOD:**

Exam 1 (October 22, 2002, CAMP 175, 6:30-8:00) 20%

Final Exam (Final Exam week) 30%
Computational Projects 30%
Lab work 10%
Homework 10%

**COURSE DESCRIPTION**

Review of viscous flow theory. Creeping flows around a sphere. Drag and lift forces acting on particles. Introduction to aerosols. Diffusion of aerosols in laminar flows. Brownian motion and Langevin equation. Mass diffusion in pipe and boundary layer flows. Effects of electrostatics, van der Waals and other surface forces. Computational aspects of aerosol dispersion in laminar flows. Particle adhesion and particle removal from surfaces. Coagulation of aerosols due to Brownian movements. Experimental techniques for particle adhesion measurements. Clean room equipment. Applications to microcontamination control, xerography, surface cleaning in microelectronic and imaging industries.

**REFERENCES**


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5. F. White, Viscous Flow, McGraw Hill (1974).
6. R.L. Panton, Incompressible Flow, John Wiley (1984).
7. H. Schlichting, Boundary Layer Theory, McGraw Hill (1979).
8. J.O. Hinze, Turbulence, McGraw Hill (1975).
9. H. Tennekes and J.L. Lumley, A First Course in Turbulence, MIT Press (1981).
10. G.M. Hidy, Aerosols, Academic Press (1984).
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14. J. H. Vincent, Aerosol Science for Industrial Hygienists, Pergamon Press (1995).