ME 437 PARTICLE TRANSPORT, DEPOSITION AND REMOVAL-I
FALL 2004

INSTRUCTOR: G. Ahmadi, Room 267 CAMP (268-2322)
                        Office Hours: MW 1:00 - 3:15 p.m., T 1:30 - 2:00 p.m.
TEXT: None. Lectures notes are available on the web.

COURSE WEB SITE: http://www.clarkson.edu/projects/crcd/

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 21, 2004, CAMP 178, 6:30-8:00 pm) 25%
Final Exam (Final Exam week) 30%
Computational Projects 30%
Lab work 5%
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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