MATSE447 Fall Semester 2012
Polymer Rheology and Processing
MWF 2:30 pm, 104 Steidle Bldg.
Professor Evangelos Manias, 325 Steidle Bldg.
863-2980 manias@psu.edu
Office Hours: MW 1:30 - 2:30 pm; TR-afternoon by appointment


Syllabus

I. Basic Fluid Mechanics (4+ weeks)
Stress, strain, tensors, viscosity, modulus, conservation of mass, momentum transfer, Navier-Stokes equations, Reynolds number, creeping flow, Poiseuille flow, Couette flow, dimensional analysis and scaling.

II. Rheology (8+ weeks)
Linear viscoelasticity, stress relaxation, oscillatory shear, creep and creep recovery, Boltzmann superposition, nonlinear viscoelasticity, steady shear, normal stresses, transient shear flows, rotational rheometers, capillary/slit rheometers, simple nonlinear viscosity models, time-temperature superposition, molecular models, entanglement, concentration effects, crosslinking reactions (gelation), extensional flows.

III. Processing (3 weeks)
Extrusion, pumping, mixing, screw design, die design, die swell, injection molding, mold filling, computer-aided mold design, weld lines, compression molding, sheet extrusion, thermoforming, pipe extrusion, blow molding, film blowing, rotational molding, fiber spinning, profile extrusion, coating, reaction injection molding.
MATSE447 Assignments & Grading

There will be 6 to 9 homeworks (depending on class progress and performance). There will be 3 in-class exams, and a written final exam.

All homeworks are due at the start of class (2:30 pm) on the pre-assigned day. The three in-class exams will be during scheduled class times (MWF 2:30 – 3:20 pm)

Grading

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Homeworks</td>
<td>25%</td>
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<tr>
<td>Exam #1</td>
<td>25%</td>
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<tr>
<td>Exam #2</td>
<td>25%</td>
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<tr>
<td>Exam #3</td>
<td>25%</td>
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<td>Final Exam</td>
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<tr>
<td>(Total)</td>
<td>125%</td>
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We drop the lowest exam score relative to the mean.
Grading is done with an excellent score corresponding to 100%.

TAs
<none>

Students are encouraged to collaborate and work jointly to complete homework assignments (you may hand in a single collaborative homework for teams up to 3 students). Students are also encouraged to seek homework help from their professor.

Students must work independently on all examinations.

Academic Integrity
For our expectations regarding Academic Integrity, see:
http://www.psu.edu/ufs/policies/
Prerequisites
MatSE443 (Introduction to Polymers), CALCULUS, and PHYSICS

Two Hour Reserve Books (Deike Library)

RHEOLOGY

PROCESSING

TEXT
Melt Rheology and its Role in Plastics Processing
JOHN M. DEALY and KURT F. WISSBRUN

1. Introduction to Rheology (40 pages, Exam#1)
2. Linear Viscoelasticity (58 pages, Exam#1)
3. Introduction to Nonlinear Viscoelasticity (47 pages, partially covered, Exam#2)
4. Steady Simple Shear Flow and the Viscometric Functions (24 pages, Exam#2)
5. Transient Shear Flows Used to Study Nonlinear Viscoelasticity (50 pages, Exam#2)
6. Extensional Flow Properties and Their Measurement (35 pages, Exam#3)
7. Rotational and Sliding Surface Rheometers (25 pages, Exam#2)
8. Flow in Capillaries, Slits and Dies (43 pages, Exam#2)
9. Rheo-Optics and Molecular Orientation (18 pages, skipped)
10. Effects of Molecular Structure (24 pages, Exam#1and2)
11. Rheology of Multiphase Systems (18 pages, skipped)
12. Chemorheology of Reacting Systems (20 pages, skipped)
13. Rheology of Thermotropic Liquid Crystal Polymers (15 pages, skipped)
15. Role of Rheology in Injection Molding (16 pages, supplemented from Middleman, Fundamentals of Polymer Processing, Exam#3)
16. Role of Rheology in Blow Molding (20 pages, Exam#3)
17. Role of Rheology in Film Blowing and Sheet Extrusion (25 pages, partially covered, Exam#3)
18. On-Line Measurement of Rheological Properties (8 pages, skipped)
19. Industrial Use of Rheometers (32 pages, skipped)

ADDITIONAL SUBJECTS
Coating Thin Films from Solution (see Middleman book, Final Exam)
Profile Extrusion (Final Exam)
Reaction Injection Molding (see Macosko, Fundamentals of R.I.M., Final Exam)
Rotational Molding (Final Exam)
Wire Coating (see Middleman book, Final Exam)