ME-470: ENGINEERING PROPERTIES OF PLASTICS MONDAY, WEDNESDAY, FRIDAY, 8:00 AM - 9:25 AM, ITC 1205

COURSE SCHEDULE

ME-470-102
Monday: 4:00 PM - 5:25 PM, ITC 1205
Thursday: 4:00 PM - 5:25 PM, ITC 1205

INSTRUCTOR:
Dr. K.A. Narh, 330 MEC
Phone: (973) 596-3353, Email: narh@njit.edu

TEXTBOOK:

SUPPLEMENT:

OBJECTIVES:
Students will learn the unique properties of the various commercial thermosetting and thermoplastic resins. An introduction to viscoelastic theory and its relationship to measurable properties of plastics. Students will also be introduced to fracture mechanics of plastics. Other engineering properties such as fatigue resistance, flammability, chemical resistance, and electrical properties will be presented. Material selection procedure for design of plastic products will also be presented.

LECTURES:
The lectures will be based on the assigned reading from the required textbook, notes and other related materials. A proposed course schedule is attached. This is offered as a guideline and may be changed throughout the semester. The scope of the design project will be discussed in class.

HOMEWORK:
All homework problems will be reviewed in class no sooner than 2 lectures after their assignment. Homework solutions must be done with microprocessor and Math software. Use MS Excel or any other Software for ALL your graphs.

EXAMS & QUIZZES
There will be two exams and 5 quizzes during the semester. There will be NO make up exams.

FINAL GRADE:
Course average is based on exams, homework and a project paper:

<table>
<thead>
<tr>
<th>Item</th>
<th>Weight (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam 1</td>
<td>20</td>
</tr>
<tr>
<td>Quizzes (5 in total)</td>
<td>15</td>
</tr>
<tr>
<td>Homework</td>
<td>10</td>
</tr>
<tr>
<td>Course Project</td>
<td>25</td>
</tr>
<tr>
<td>Final Examination</td>
<td>30</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

GRADING SCALE:
The grading scale will be as follows: A (90-100); B+ (85-89);
B (80-84); C+ (75-79); C (70-74); D (56-69); F (<55)

CLASS RULES:
Late Homework submissions NOT ALLOWED.
Sleeping in class unacceptable.

TURN OFF ALL CELL PHONES
<table>
<thead>
<tr>
<th>WEEK</th>
<th>TOPIC</th>
<th>READING/ASSIGNMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Plastic Materials: An Overview</td>
<td>Identify 30 products manufactured from polymers</td>
</tr>
<tr>
<td></td>
<td><strong>Basic concepts and definitions:</strong> Monomers, Polymerization, Polymers</td>
<td>McCrum et al. Chapter 1</td>
</tr>
<tr>
<td></td>
<td><strong>Polymeric chains &amp; Molecular Networks:</strong> Cross-linking and chain branching Molecular weight and molecular weight distribution</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thermoplastics, Thermosets, Elastomers</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Physical States and Transitions Amorphous, Glassy &amp; Rubbery states: <strong>Glass Transition Temperature T\text{g} and T\text{m}</strong></td>
<td>McCrum et al. Chapter 2</td>
</tr>
<tr>
<td></td>
<td><strong>Crystalline State:</strong> morphology, crystallization kinetics</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td><strong>Mechanical Properties</strong></td>
<td>Belofsky, 5</td>
</tr>
<tr>
<td>6</td>
<td>Midterm Test</td>
<td></td>
</tr>
<tr>
<td>7/8</td>
<td><strong>Manufacturing Methods and Product Characteristics</strong> Tour of Plastics Processing Laboratory</td>
<td>McCrum et al. et al. 7 Identify Manufacturing Methods for list in Assn. 1</td>
</tr>
<tr>
<td>9</td>
<td><strong>Thermal Properties</strong> Thermal properties - specific heats, thermal conductivity and diffusivity, differential scanning calorimetry (DSC) Measurement of Thermal Data</td>
<td>Belofsky, 3</td>
</tr>
<tr>
<td>10</td>
<td><strong>Electrical Properties</strong> - comparative tracking index, dielectric strength, arc resistance measurement and test methods</td>
<td>Belofsky, 6</td>
</tr>
<tr>
<td></td>
<td><strong>Optical Properties:</strong> color, gloss and haze, measurement and test methods</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td><strong>Environmental Testing</strong> Weathering, Chemically aggressive environment, Flammability &amp; Combustion</td>
<td>Belofsky, 6, 18</td>
</tr>
<tr>
<td></td>
<td><strong>Additives</strong> - effect on properties. Alloys - synergisms. Composites - reinforcing fibers, orientations, anisotropy, laminates</td>
<td>McCrum et al. 6; Belofsky 12</td>
</tr>
<tr>
<td>12-14</td>
<td><strong>Term Project</strong> Materials Selection Procedure</td>
<td>McCrum et al. Chapter 8</td>
</tr>
<tr>
<td>15</td>
<td>Term Project Due</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Final Examination.</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:**
The reading assignments for the textbook are listed in the syllabus. Unfortunately, there are topics that will be covered that are not covered as well as I would like or are not covered at all. I will supplement the text via lectures and via handouts of additional material.
Design Project:

Design a NOVEL or everyday plastic product. Perform Stress Analysis using FE and CAE software.

Design Project Requirements

The design project is a team-based assignment. The scope is limited by the semester time frame. It is, however, critical that each student understands the expected outcomes.

Design one of the following products using CAD software, perform stress analysis and write a Report.

- Plastic Pump for an Automobile
- Replacement Knee
- Heart Valve
- Motor Cycle Wheel
- Water Hose Nozzle/Spray

Additional Products

a. Pipe for (underground) mains gas supply;
b. Automobile front bumper;
c. Football helmet;
d. Domestic kettle;
e. Telephone handset;
f. Socket for 100 W electric light bulb;
g. Automobile door handle;
h. Incubator for premature baby unit;
i. Space shuttle control panel;
j. F16 fighter canopy;
k. Firefighter face-shield;
l. Ski boot sole;
m. Wristwatch gear.

Project Scheduling:
The project schedule is defined by the team. The team will select from the above list, obtain approval for a design not on the list, generate a design, perform stress analysis using a CAE software (such as ANSYS or PROMECHANICA) based on the Team’s own scenario, and submit a Design Report.

Your Report MUST INCLUDE the following:

- Abstract or Executive Summary
- Problem Statement
- Objectives
- Material Selection: (Discuss performance criteria for the product, which must include factors to be considered in selecting the plastic for the part: e.g. mechanical, thermal, environmental, electrical, economical, appearance etc (see attached list).
- Design of part including drafts and full dimensions.
- Stress Analysis Results
- Manufacturing Consideration.
- Conclusions
- Appendix

04S