

## MAT 402 Polymer Engineering II

**Instructor:** Dr. Ozge Akbulut,

**TA:**

**Course meeting times:** ----. There are no recitations for this class, but you are encouraged to make use of the Instructor's office hours for assistance.

**Scope:**

The aim of the class is to equip students with 1) polymer processing techniques and the effect of these processing techniques on polymer structure, 2) aspects of designing polymeric devices and polymer additives, 3) the properties of reinforced polymers and related reinforcement methods. Students are assumed to have basic knowledge on polymer structure-property relationship from Polymer Engineering I and/or ENS 205 classes. The target audience is materials science and engineering, industrial engineering, and mechatronics majors.

**Learning outcomes:**

1. Describe how polymers are processed in industry
2. Describe how processing affects internal microstructure and thus polymer properties
3. Use this understanding in the design of commercial processes for polymer-based objects
4. Apply principles of polymer processing and knowledge on the microstructure of polymers to define properties and functionality for commercial items
5. Use theory in the design of polymeric products and manufacturing processes
6. Specify suitable manufacturing processes for a range of commercial items

**Recommended reading:**

McCrum, N. G., Buckley, C.P. and Bucknall, C.B. *The Principles of Polymer Engineering*, 2<sup>nd</sup> ed.; Oxford University Press: Oxford, New York, Tokyo, 1997.

Ashby, M. F. *Materials Selection in Mechanical Design*, 2<sup>nd</sup> ed.; Butterworth-Heinemann: Oxford, Boston, 1999. (This book is also available as an electronic resource in IC Database)

**Grading:** The grading will be based on one term exam (25%), one group project (20%), homework (25%), and a final (30%).

Three site visits to (We will discuss how to carry these out online):

Farplas: Injection molding, extrusion, thermoforming

AKSA: Fiber production

Fark Labs: Product design, entrepreneurship

**Group project:** Students are expected to analyze the manufacturing of a plastic product in three steps:

- 1) Specification of the product
  - Its function, drawings, expected performance, conditions of use and cost, market.
- 2) Specification of the process
  - Process type, flow map, and conditions.
- 3) Specification of the equipment
  - Technical specifications, price offers, other products that can be made with that equipment
- 4) Presentation

**Week 1**

Introductory lectures (Background on polymers)

**Week 2**

Use of polymers in daily life and high-technology products (e.g., in textile and civil engineering)

Introduction to the Design Project

Industry 4.0, multifunctionality, custom-design, economy

**Week 3**

Flow properties of polymer melts

**Week 4**

Extrusion process I

**Week 5**

Extrusion process II

Student presentations

**Week 6**

Polymer film production (Blown film, cast film)

**Week 7**

Injection molding

Mold and process design

**Week 8**

Thermoforming, blow molding, compression and transfer molding

**Week 9**

Fabrication of reinforced plastics

**Week 10**

Micro/nanofabrication methods involving polymers

**Week 11**

Silicone-based products and their fabrication

Student presentations

**Week 12 and 13**

Design for manufacture, design for strength, design for toughness and design for X.

**Week 14**

Student presentations and wrap up