

MAT 402 Polymer Engineering II

Instructor: Dr. Ozge Akbulut,

TA: Isik Arel

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 and specify suitable manufacturing processes for a range of commercial items
2. Describe how processing affects internal microstructure and thus polymer properties and apply this knowledge to define properties and functionality for commercial items
3. Use this understanding in the design of commercial processes for polymer-based objects
4. Use theory and computational tools in the design of polymeric products and manufacturing processes including life-cycle analysis for these products.

Note: We may have to revise the course plan according to the countrywide reassessment to be made regarding higher education. This is expected to happen at the beginning of April. The content to be delivered is certain but the method of course delivery, the number and dates of exams, and some other details are subject to change.

Recommended reading:

McCrum, N. G., Buckley, C.P., and Bucknall, C.B. *The Principles of Polymer Engineering*; Oxford University Press: Oxford, New York, Tokyo, 1997.

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

Osswald, T. A. & Menges, G. *Materials Science of Polymers for Engineers*; Carl Hanser Verlag: Munich, 2012.

Francis, L.F., *Materials Processing: A Unified Approach to Processing of Metals, Ceramics and Polymers*; Academic Press, 2016.

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:

Farplas: Injection molding, extrusion, thermoforming

Elif Packaging: Film 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.
 - Life-cycle analysis of the product
- 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)

Industry 4.0, multifunctionality, custom-design, economy

Introduction to circular economy

Week 2

Use of polymers in daily life and high-technology products

Introduction to the Design Project

Life cycle analysis: <https://simapro.com/>

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

Invited lecture on circular economy by DCube//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