Course Syllabus

EMAC276 Polymer Properties & Design

Time: MWF, 10:35P.M. - 11:25P.M., spring semester 2025

Location: Nord 204

Instructor: Dr. Lei Zhu, Professor of Macromolecular Science and Engineering

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Co-Instructors: Dr. Andrew Olah, Adjunct Professor

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Course Description (3 credits):

The course reviews chemical and physical structures of a wide range of applications for synthetic and natural polymers, and addresses “Which polymer do we choose for a specific application and why?” We examine the polymer properties, the way that these depend on the chemical and physical structures, and reviews how they are processed. We aim to understand the advantages and disadvantages of the different chemical options and why the actual polymers that are used commercially are the best available

in terms of properties, processability and cost. The requirements include several written assignments and one oral presentation.

Prerequisite: ENGR 145 and EMAC 270.

Course Objectives:

This course serves as an introduction to the synthesis, properties, design and applications of industrially relevant synthetic polymers, which include polyolefins (e.g., polyethylene and polypropylene), vinyl polymers [e.g., polystyrene, poly(vinyl chloride)], diene polymers (e.g., rubbers), polyesters, polyamides, polyimides, silicone polymers, polyurethanes, epoxy polymers, etc. We aim to achieve the following objectives:

1. i) Understand industrial scale synthesis of certain important polymers;
2. ii) Understand the basic structure and properties of these polymers. These properties include thermal, mechanical, melt viscosity, and electrical properties;

iii) Know the design of polymeric materials and their applications. In particular, know how polymer products work.

1. iv) Be able to design a component (structural or otherwise) to be made from polymers, reflecting a practical understanding of ultimate thermal and mechanical properties of relevance to an application.

Optional Textbook:

96. Feldman and A. Barbalata, *Synthetic Polymers: Technology, Properties, Applications*; Chapman & Hall: London, 1996.

This book can be used as a general reading, and you are not required to purchase it. Some closely related chapters will be posted on Canvas. If you need the book, you can borrow through Case library (only one copy) or Ohiolink.

Study Groups:

Study groups will consist of ~5 students. The purpose of the study groups is to provide peer-support from the homework and to work as a team on a project related to materials specification and selection.

Grades: Homework: 15%

In-class quizzes: 10%

Final design project: 15% (oral 6% + report 9%)

Mid-term and final exams: 30% + 30%

Homework Assignment and In-class Quizzes:

Given the nature of this course, which is qualitative and information-based, we do not intend to give conventional homework assignment. Instead, take-home reading materials or online searching will be used. Short essay and in-class quizzes will be used to assess the reading and searching results.

Homework will be collected one week after being assigned. Although the homework will be graded, the homework/quiz grades will represent only a small part (25%) of your final grade. The homework you turn in should be your work alone; however, you are encouraged to discuss the homework in study groups. Generally, we will not answer questions concerning the homework. We expect that you will learn the material better by working through the homework on your own or with the study group. Late homework will be penalized 4% per weekday or weekend (Saturday + Sunday). No homework will be accepted after May 1st, 2023.

Exams:

There will be two exams at the end of each teaching period by Prof. Olah and Prof. Zhu. These exams will not be cumulative.

Final Project:

Each study group is responsible for a project involving materials specification and selection. An oral presentation (10 min) will be given at the end of the class. Details will be announced in class.

Emphasis on Ethical Considerations:

Cheating in any formats in exams, quizzes, and homework assignment is strictly forbidden throughout the course. Whoever commits cheating will be fully responsible for the consequences.

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Dates in 2025	Subjects	Homework
	Introduction to Polymer Industry	
Jan. 13 – 31 (Dr. Olah)	Hierarchical Structures	Assignment #1
	Mechanical Properties of Polymers	
	Styrenic Polymers	
	Polyolefin Polymers	Assignment #2
Feb. 10 – Mar. 7 (Dr. Olah)	Vinyl Polymers	
	Diene Polymers	Assignment #3
	Silicone Polymers	
Mar. 7	**Exam #1**	
Mar. 10 - 14	Spring Break	
Feb. 3 – 7 (Dr. Zhu)	Polyesters: Thermal Plastic and Thermosets	Assignment #4
Mar. 17 – April 23 (Dr. Zhu)	Polyamides and Polyimides	Assignment #5
	Polyurethanes	
	Epoxy Polymers	Assignment #6
Apr. 25 and 28	Final Project Presentation:	Final project presentation and

	Please use what you have learned in this course to design a polymer project that can replace wood, metals or ceramics	report Due on Apr. 28
May 1-8	**Exam #2**	
May 10	**Final Grades**	

Note: If possible, we will arrange two lab observations for 3D printing of polymers (Thinkbox). These will help you understand some of the course content and broaden your knowledge.

Course Summary:

Date	Details	Due