

SYLLABUS

Mat E 455 (Spring) Polymer Technology and Engineering

EB3-02232

Prof. Martin Thuo

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Prerequisites: MSE 380

Lectures: TTh 8:30-9:45 am

Virtual Office Hours: W 10:00 am (<https://ncsu.zoom.us/j/94654570751?pwd=M3Arc0Y3UWh3a2hyNjkxNG5aVjkzZz09>
Meeting ID: 946 5457 0751 Passcode: 674099)

Textbook: "Principles of polymer Processing, 2nd ed" by Z. Tadmor, C.G. Gogos

Course Content: **Chapters 1-15+**

Supplementary Materials:

- 1) "Introduction to polymers" by R.J. Young & P.A. Lovell
- 2) "Polymer Processing: principles and design", 2nd ed. Wiley, 2014 by Baird & Collias

Overview: The course is divided into three parts. Part 1 is back to basic ('what') looks at the fundamental knowledge we need to understand and exploit polymer technology(ies), part 2 ('how') looks at details of how we process polymers and the underlying science in these processes, part 3 ('why') takes the case of polymer composites and uses it to expound on why an interdisciplinary and broad set of knowledge is needed, with the understanding that this can result in unprecedented material properties and performance.

Exams (400 pts): Two in-class exams (100 pts each) and a comprehensive final (200 pts) will conclude the semester evaluations. In addition to completing the homework and all other requirements for MSE 455, students enrolled in MSE 555 will also be required to complete additional, more advanced homework problems. **I will not have makeup exams.**

Homework: (150 pts): we will have multiple graded homework and will come as needed – low participation triggers extra homework. The assignments will be posted online and are due the following Wednesday before class starts. I may introduce more homework and/or pop-quiz as needed. No late (5 minutes after class starts) homework will be graded.

Oral Presentations (100 pts): we will present in groups that will be randomly organized from the class list. You will get a chance to choose your topic on a first-come first-serve basis after the first mid-term. You will earn team points and individual points. All talks will be 15 minutes with 5 minutes of question. Graduate students will get an extra assignment and this presentation will be prior to the end of semester presentations. Virtual students can record a video of their presentation and share it with us.

A list of testing ASTM standards will be assigned, and it is your responsibility to pull up these standards, analyze them (pro and cons), then summarize these to the class. I will assign ASTM standards that have been withdrawn so find out why and using what we have covered in class, justify the withdrawal. A grading rubric will be posted on moodle (under assignments) and it is the students responsibility to bring one to class. Failure to submit an evaluation will be taken as absence in class and will affect your grade. Each presentation must have a good set of references, Wikipedia is a good starting point but should not be used as a reference – find the appropriate journal articles and book chapters.

Participation (50 pts): your participation in class and during presentations is highly encouraged and contributes to your overall score. Part of the participation score will come from fair peer grading of the oral presentations.

INSTRUCTOR'S CLASS NOTES ONLINE: DISCLAIMER A copy of the instructor's class notes may be posted on the course's moodle page. These notes are written primarily for use by the instructor, not the student, and therefore should not

be considered as a substitute for the textbook or as an alternative to attending class and taking your own notes. These notes are provided as a courtesy to the student and are not guaranteed to contain everything students need to know for exam; however, they can provide a detailed outline of any special topic/clarification(s) discussed in class. This content is examinable.

Catalog description of the Course:

MSE 455/555/655. POLYMER TECHNOLOGY AND ENGINEERING. (3-0) Cr. 3. Prereq: MSE 380. This course will cover commercial polymers, polymer blends and miscibility, dynamic mechanical behavior, Boltzmann superposition principle, ultimate properties of polymers, polymer rheology and processing, recycling and design and selection of polymeric materials. Where possible, guest instructors from industry will give presentations on contemporary topics in polymer technology and engineering. *Polymer composites processing and their mechanical properties.*

Field trips are required.

Specific outcomes of instruction:

By the end of this course, students will be able to:

- Describe the mechanical behavior of rubber using thermodynamic theory of rubber elasticity
- Derive equations for and interpret the behavior of spring-dashpot models for polymer viscoelasticity
- Analyze thermos-mechanical data to select polymers based on their stiffness
- Explain the connection between time and temperature and their effects on polymer properties
- Describe the effects of plastic deformation on polymer morphology
- Describe and explain injection molding, extrusion and other processing methods for producing plastic parts
- Identify the various classes of commercial polymers based on their properties and applications
- develop an understanding of properties of polymer composites processing, structure and properties

ABET Student outcomes addressed:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
 3. an ability to communicate effectively with a range of audiences.
 5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
 7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies
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UNIVERSITY POLICIES

Academic Integrity and Honesty

Students are required to comply with the university policy on academic integrity found in the [Code of Student Conduct](#). Therefore, students are required to uphold the university pledge of honor and exercise honesty in completing any assignment.

Please refer to the [Academic Integrity](#) web page for a detailed explanation of the University's policies on academic integrity and some of the common understandings related to those policies.

Students may be required to disclose personally identifiable information to other students in the course, via electronic tools like email or web-postings, where relevant to the course. Examples include online discussions of class topics and posting of student coursework. All students are expected to respect the privacy of each other by not sharing or using such information outside the course.

Students are responsible for reviewing the NC State University PRR's which pertains to their course rights and responsibilities:

- > [Equal Opportunity and Non-Discrimination Policy Statement](#) and [additional references](#)
- > [Code of Student Conduct](#)
- > [Grades and Grade Point Average](#)

> [Credit-Only Courses](#)

> [Audits](#)

Student Services

Accessing University Resources

There are additional links to student services available to you in the Student Services block located in the block drawer on the right side of the course site. These services include: Academic Support, community, health and wellness, basic needs, financial assistance, and other campus resources. To open the block drawer click on the button that looks like an arrowhead on the right side of the main course page. You can close the block drawer by clicking on the X.

Disability Services

Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with the Disability Resource Office at Holmes Hall, Suite 304, Campus Box 7509, 919-515-7653 . For more information on NC State's policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation (REG02.20.01)

Trans-Inclusive Statement

In an effort to affirm and respect the identities of transgender students in the classroom and beyond, please contact me if you wish to be referred to using a name and/or pronouns other than what is listed in the student directory.

Basic Needs Security

Any student who faces challenges securing their food or housing or has other severe adverse experiences and believes this may affect their performance in the course is encouraged to notify the professor if you are comfortable in doing so. Alternatively, you can contact the Division of Academic and Student Affairs to learn more about the Pack Essentials program <https://dasa.ncsu.edu/pack-essentials/>

COURSE EVALUATIONS

ClassEval is the end-of-semester survey for students to evaluate instruction of all university classes. The current survey is administered online and includes 12 closed-ended questions and 3 open-ended questions. Deans, department heads, and instructors may add a limited number of their own questions to these 15 common-core questions.

Each semester students' responses are compiled into a ClassEval report for every instructor and class. Instructors use the evaluations to improve instruction and include them in their promotion and tenure dossiers, while department heads use them in annual reviews. The reports are included in instructors' personnel files and are considered confidential.

Online class evaluations will be available for students to complete during the last two weeks of the semester for full semester courses and the last week of shorter sessions. Students will receive an email directing them to a website to complete class evaluations. These become unavailable at 8am on the first day of finals.

> Contact ClassEval Help Desk: classeval@ncsu.edu

> [ClassEval website](#)

> [More information about ClassEval](#)

SYLLABUS MODIFICATION STATEMENT

Our syllabus represents a tentative, flexible agreement. It outlines the topics we will cover and the order in which we will cover them. Dates for assignments represent the earliest possible time they would be due. The pace of the class depends on student mastery and interests. Thus, changes in the syllabus can occur if we need to slow down or speed up the pace of instruction and in cases where the interest of the class shifts and there is a need to introduce a new topic.

STUDENT DISCUSSION FORUM

A Student Discussion Forum has been set up on the Moodle course web page. All students enrolled in this course can use this forum to ask questions and discuss course topics with other students in the class. I especially encourage students to work together on homework problems. You can use the Forum to facilitate this. I will monitor this forum, but will not participate unless I find several students having the same question.

TENTATIVE LECTURE SCHEDULE

Date	Topic	Reference	Event/Task
1	Syllabus: Definitions and policies. Introductions		Homework 1
	Part 1: Polymer Solutions		
2	Thermodynamics of mixing-ideal and dilute solutions		
3	Thermodynamics of mixing- solubility parameters		
4	Concentrated solutions and Polymer blends		
5	Block polymers and Phase segregation		Homework 2
6	Characterization methods		
7	Mechanical properties – viscoelasticity		
8	Mechanical properties – block polymers		
9	Review (or catchup)		
02-08	Midterm 1		
02-13	Wellness day		
	Part 2: Polymer Rheology & Processing		
11	Historic perspective on Polymer processing	Chpt 1	
12	Handling Particulates	Chpt 4	Homework 3
13	Fluid flow and conservation relations 1	Chpt 2	
14	Fluid flow and conservation relations 2		
15	Fluid flow and conservation relations 3		
16	Polymer Rheology/ non-Newtonians 1	Chpt 3	
17	Polymer Rheology/ non-Newtonians 2	Chpt 3	
03/11-15	Spring Break		
03-19	Midterm 2		
19	Polymer Rheology/ non-Newtonians 3		
20	Melting	Chpt 5	Homework 4
21	Pressurizing & pumping	Chpt 6	
22	Extrusion, reactive polymers, shaping, molding, & calendering	Chpt 9-15	
23	Polymer recycling		
	Part 3: Polymer Composites properties & Processing		
24	Rule of mixtures		
25	Lamina mechanics 1		Midterm 4 (take home)
26	Lamina mechanics 2		
27	Laminate mechanics		
28	Composite processing		

Course Grading:

A+ (≥ 97), A (93-97), A- (90-93), B+ (87-90), B (83-87), B- (80-83), C+ (77-79), C (73-77), C- (70-73), D (67-70), D- (63-67), D- (60-63), F (<60)