



Faculty of Engineering and Applied Science

CHEE 490 – POLYMER FORMULATIONS AND PROCESSING TECHNOLOGY

Course Syllabus – Winter 2022

This is your course syllabus. Please download the file and keep it for future reference.

LAND ACKNOWLEDGEMENT

Queen's University is situated on traditional Anishinaabe and Haudenosaunee Territory.
See: <http://www.queensu.ca/encyclopedia/t/traditional-territories>

INCLUSIVITY STATEMENT

Queen's students, faculty, and staff come from every imaginable background – small towns and suburbs, urban high rises, Indigenous communities, and from more than 100 countries around the world. You belong here: <https://www.queensu.ca/inclusive/>.

TEACHING TEAM

COURSE INSTRUCTOR

Ying Zhang, Ph.D., P.Eng.

Department of Chemical Engineering
Queen's University

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Office hours: Fri. 2:00 pm – 3:00 pm (Zoom)



TEACHING ASSISTANT

Raz Abbasi

E-mail: 21ra37@queensu.ca
Office hours: By appointment



COURSE INFORMATION

COURSE DESCRIPTION

The design and manufacture of polymer products is reviewed, with particular emphasis on material selection and processing technology. The engineering properties of elastomers, thermoplastics, adhesives, fibres and coatings are discussed in terms of processing characteristics and end-use performance. Industrial processing operations such as extrusion, moulding, mixing and film manufacture are presented in detail. The design component of the course requires students to select appropriate materials and processing methods for an engineering application. Examples include medical catheters, engine gaskets and biodegradable packaging.

PREREQUISITES: CHEE 223 or MECH 241, or permission of the department

(0/0/0/30/12) (Mathematics/Natural Sciences/Complementary Studies/Engineering Science/Engineering Design)

COURSE LEARNING OUTCOMES (CLO)

Specific course learning outcomes include:

| CLO | DESCRIPTION | INDICATOR |
|------------|--|--|
| CLO 1 | Classification of polymers, identification of their physical properties and establishing structure-property relations. | KB-ES (Applied Chemistry) |
| CLO 2 | Formulation of polymeric compounds to meet specific product properties. | KB-ES (Applied Chemistry) DE-Define DE-Solutions |
| CLO 3 | Knowledge of polymer processing operations and choice of operation depending on the material and final product requirements. | KB-ES (Process) DE-Define DE-Solutions |
| CLO 4 | Interpretation and analysis of rheological data using models for non-Newtonian fluids. | KB-ES (Transport Phenomena) |
| CLO 5 | Identification of methods for rheological measurements and analysis of the results. | KB-ES (Transport Phenomena) |

| CLO | DESCRIPTION | INDICATOR |
|-------|--|--|
| CLO 6 | Solution of simple flow problems and calculations in extrusion and injection moulding. | KB-ES (Process) KB-ES (Transport Phenomena) |

This course assesses the following program indicators:

Knowledge base for engineering science (KB-ES) (CLOS 1, 2, 3, 4, 5, 6)

KB-ES (Applied Chemistry) Applies fundamental principles of colloid, surface and material science to the analysis and assessment of colloidal and surface interactions and materials.

KB-ES (Process) Applies engineering principles to do engineering calculations and size various unit operations, including pumps, heat exchangers, separation processes, and reactors.

KB-ES (Transport Phenomena) Formulates and applies differential mass, momentum and energy balances to do engineering calculations; Identifies mechanisms of momentum, heat and mass transfers and formulates and applies appropriate constitutive models to describe fluid behaviour.

Design (DE) (CLOS 2, 3)

DE-Define Define problem, objectives and constraints.

DE-Solutions Create a product, process or system to solve a problem, that meets specified needs, and subject to appropriate iterations.

COURSE EVALUATION

ASSESSMENT WEIGHTING

| Assessment Tool | Due Date (before 23:59 ET) | Weight | Alignment with CLOs |
|-----------------------|--|-------------|------------------------|
| Assignments | Day 1 of Weeks 2,4,6,9,10,11,12 | 11% | 1, 4, 5, 6 |
| Assignment 1 | Day 1 of Week 2 | 1.57% | 1 |
| Assignment 2 | Day 1 of Week 4 | 1.57% | 1 |
| Assignment 3 | Day 1 of Week 6 | 1.57% | 1 |
| Assignment 4 | Day 1 of Week 9 | 1.57% | 4 |
| Assignment 5 | Day 1 of Week 10 | 1.57% | 4, 5 |
| Assignment 6 | Day 1 of Week 11 | 1.57% | 4, 6 |
| Assignment 7 | Day 1 of Week 12 | 1.58% | 4, 6 |
| Midterm | Day 4 of Week 6 | 22% | 1, 2 |
| Design Project | Day 7 of Weeks 6, 12 | 22% | 2, 3, |
| Parts 1 and 2 | Day 7 of Week 6 | 11% | 2 |
| Part 3 | Day 7 of Week 12 | 11% | 3 |
| Final Exam | Day 7 of Week 12 | 45% | 3, 4, 5, 6 |
| | | 100% | |

Students are expected to complete their work in a timely fashion. The course instructor will provide notification (in lecture and on course website) of due dates and any revisions thereof.

Submissions after the due date will be penalized at up to 20% per day unless suitable justification is provided.

Students must pass the exam component (combined mark on midterm + final) to pass the course, as stated by [departmental policies](#).

Unless other arrangements have been approved, [departmental policies](#) regarding late and missed assignments, and missed quizzes/exams will be followed.

Remote Proctoring - Proctortrack

The midterm in this course will use remote proctoring provided by a third-party, cloud-based service that enables the completion of a proctored exam or test from an off-campus location, through onQ. This online proctoring solution was chosen as part of the approach to maintaining academic integrity in online assessment. Precise details about how remote proctoring will be used in this course can be found in the “Getting Started with Remote Proctoring” content module in onQ or will be provided by the instructor.

When writing exams using remote proctoring, you are connecting to the third-party service. Queen’s has conducted a privacy and security review of the service in accordance with Ontario’s privacy legislation.

You should also take measures yourself to protect your information by keeping your NetID password and challenge questions private, closing all applications prior to starting an exam/test, and ensuring your device is updated and safeguarded against malware.

For more information about remote proctoring, see the Student FAQs on the OUR Exams resource page for [remote proctoring](#).

GRADING

All assessments in this course will receive numerical percentage marks. The final grade you receive for the course will be derived by converting your numerical course average to a letter grade according to the established [Grade Point Index](#).

Accessing Your Final Grade

Your final grades will show on SOLUS. Official transcripts showing final grades will be available on the Official Grade Release Date. Please note that in official transcripts, a mark of IN (incomplete) is considered a grade, and your transcript is released with this grade.

COURSE MATERIALS

Required Textbook

- J.R. Fried, "Polymer Science and Technology", 3rd Ed. Prentice Hall, 2014

Additional Textbooks (optional)

- S.L. Rosen, "Fundamental principles of polymeric materials", 3rd Ed. Wiley, 2012
- T.A. Osswald, "Polymer processing fundamentals", Hanser, 1998

Course notes and other course-related material

All other course material is accessible via OnQ.

Required Calculator

A Casio 991 is required. **ONLY** this type of non-programmable, non-communicating calculator will be allowed during tests and exams.

Required Hardware/Software

Students must have a reliable [internet connection and hardware](#) that are compatible with online learning and remote proctoring system requirements.

Course Specific Computer-Related Skills

Students must have proficiency in Excel or other equivalent data processing/analysis softwares.

Suggested Time Commitment

This course represents a study period of one semester spanning 12 weeks. Learners can expect to invest on average 7-9 hours per week in this course. Learners who adhere to a pre-determined study schedule are more likely to successfully complete the course.

COURSE OVERVIEW

| CHEE 490 Module overview | | | |
|---|--|---|--|
| Course learning outcomes (CLO): Students will be able to: | | | |
| <ol style="list-style-type: none"> 1. Classify polymers, identify their physical properties and establish structure-property relations. 2. Formulate polymeric compounds to meet specific product properties. 3. Choose appropriate polymer processing operations depending on the material and final product requirements. 4. Interpret and analyze rheological data. 5. Identify methods for rheological measurements and analyze the results. 6. Solve simple flow problems and perform simple calculations in extrusion and injection moulding. | | | |
| Students are expected to augment lecture material through reading of associated sections of the textbook, and to practice execution of course principles by completing posted problem sets | | | |
| Module | Lecture approach and content | Tutorials <i>Tutorial and practice problem sets are available on onQ</i> | Assessment (CLO, and % of course grade) |
| Module 1 (Wk 1-4) | Physical properties of polymers (CLO1) <ul style="list-style-type: none"> • Classification • Molecular weight distributions • Thermal Transitions • Mechanical properties • Polymer Solubility • Interfacial Properties | Tutorials 1, 2 Problem Set 1 | Assignment 1 and 2 (CLO1). Material is included on mid-term (CLO1) |

| | | | |
|------------------------|--|---|---|
| Module 2 (Wk 5, 6) | Thermoplastic and Elastomer technology (CLO1, 2) <ul style="list-style-type: none"> • Thermoplastics: properties/additives • Rubber elasticity/crosslinking • Elastomer formulations | Tutorial 3 Problem Set 2 | Assignment 3 (CLO1). Design project parts 1 and 2 (CLO2), worth 11% of course grade |
| Midterm | Covers Modules 1-2 | Midterm review | <i>Midterm exam: 5 questions (which may include multiple choice or essay type questions) will target CLO 1 and 2, worth 22% of course grade</i> |
| Module 3 (Wks 7) | Overview of polymer processing operations (CLO3) <ul style="list-style-type: none"> • Unit operations in polymer processing • Secondary shaping operations • Compounding/polymer blends and composites | Polymer processing videos | Design assignment part 3. Material is included on final exam (CLO3) |
| Module 4 (Wks 8-10) | Calculations in polymer processing operations (CLO3, CLO6) <ul style="list-style-type: none"> • Principles of rheology • Constitutive equations/Flow modeling • Extrusion/injection molding | Tutorials 4, 5, 6, 7 Problem Set 3 | Assignment 4, 5 (CLO4, CLO5). Material is included on final (CLO4, CLO5) Assignment 6, 7 (CLO4, CLO6). Material is included on final (CLO4, CLO6), |

| | | | |
|-------------------------|--|-------------|--|
| Module 5 (Wks 11-12) | Polymer rheology (CLO4, CLO5) <ul style="list-style-type: none">• Rheometry• Dynamic mechanical properties/viscoelasticity | | Design project part 3 (CLO3), worth 11% of course grade |
| EXAM | | Exam Review | <i>Final exam: One-two questions will target each CLO, worth 45% of course grade</i> |

COURSE COMMUNICATION

NETIQUETTE

In this course, you may be expected to communicate with your peers and the teaching team through electronic communication. You are expected to use the utmost respect in your dealings with your colleagues or when participating in activities, discussions, and online communication.

Following is a list of netiquette guidelines. Please read them carefully and use them to guide your online communication in this course and beyond.

1. Make a personal commitment to learn about, understand, and support your peers.
2. Assume the best of others and expect the best of them.
3. Acknowledge the impact of oppression on the lives of other people and make sure your writing is respectful and inclusive.
4. Recognize and value the experiences, abilities, and knowledge each person brings.
5. Pay close attention to what your peers write before you respond. Think through and re-read your writings before you post or send them to others.
6. It's alright to disagree with ideas, but do not make personal attacks.
7. Be open to be challenged or confronted on your ideas and challenge others with the intent of facilitating growth. Do not demean or embarrass others.
8. Encourage others to develop and share their ideas.

QUESTIONS ABOUT COURSE MATERIAL

Questions or comments regarding the course material that can be of benefit to other students should be posted in the Q&A forum on the class website. The instructor, TAs, and students are encouraged to answer these questions directly in the discussion forum for the benefit of everyone in the course.

COURSE ANNOUNCEMENTS

The instructor will routinely post course news in the Announcements section on the main course homepage on OnQ. Please sign up to be automatically notified by email when the instructor posts new information in the Announcements section. Instructions on how to modify your notifications are found in the **Begin Here** section of the class website.

OFFICE HOURS

In addition to interaction in the Q&A discussion forums, you will have the opportunity to interact in a synchronous fashion with either a TA or the instructor through office hours. The instructor will provide a schedule of availability at the beginning of the term.

CONFIDENTIAL MATTERS

If you have a confidential matter you would like to discuss with your instructor, their contact details are on the first page of this document. Expect email replies within 48 hours.

RECORDING SYNCHRONOUS (LIVE) CLASSES

Synchronous (live) classes will be delivered in this course through a video conferencing platform supported by the University (Zoom). Steps have been taken by the University to configure these platforms in a secure manner, and to maintain student privacy while delivering courses remotely. Please note the following:

- Lectures will be recorded with video and audio (and in some cases transcription) and will be made available to students in the course for the duration of the term. You will be able to turn off your camera and microphone if you would like to.
- Tutorials **will** have mandatory participation, and **will** be recorded with video and audio.

The recordings may capture your name, image or voice through the video and audio recordings. By attending these live classes, you are consenting to the collection of this information for the purposes of administering the class and associated coursework. If you are concerned about the collection of your name and other personal information in the class, please contact the course instructor to identify possible alternatives.

To learn more about how your personal information is collected, used and disclosed by Queen's University, please see the general [Notice of Collection, Use and Disclosure of Personal Information](#).

COURSE POLICIES

Please review the following policies concerning copyright, academic integrity, absences and academic accommodations:

COPYRIGHT

Course materials created by the course instructor, including all slides, presentations, synchronous and asynchronous course recordings, handouts, tests, exams, and other similar course materials, are the intellectual property of the instructor. It is a departure from academic integrity to distribute, publicly post, sell or otherwise disseminate an instructor's course materials or to provide an instructor's course materials to anyone else for distribution, posting, sale or other means of dissemination, without the instructor's *express consent*. A student who engages in such conduct may be subject to penalty for a departure from academic integrity and may also face adverse legal consequences for infringement of intellectual property rights and, with respect to recordings, potentially privacy violations of other students.

ACADEMIC INTEGRITY

As an engineering student, you have made a decision to join us in the profession of engineering, a long-respected profession with high standards of behaviour. As future engineers, we expect you to behave with integrity at all times. Please note that Engineers have a duty to:

- Act at all times with devotion to the high ideals of personal honour and professional integrity.
- Give proper credit for engineering work

The standard of behaviour expected of professional engineers is explained in the [Professional Engineers Ontario Code of Ethics](#). Information on policies concerning academic integrity is available in the [Queen's University Code of Conduct](#), in the [Senate Academic Integrity Policy Statement](#), on the [Faculty of Engineering and Applied Science website](#), and from your instructor.

Departures from academic integrity include plagiarism, use of unauthorized materials or services, facilitation, forgery, falsification, unauthorized use of intellectual property, and collaboration, and are antithetical to the development of an academic community at Queen's. Given the seriousness of these matters, actions which contravene the regulation on academic integrity carry sanctions that can range from a warning or the loss of grades on an assignment to the failure of a course to a requirement to withdraw from the University. In the case of online exams, impersonating another student, copying from another student, making information available to another student about the exam questions or possible answers, communicating with

another person during an exam or about an exam during the exam window, or accessing unauthorized materials, including smart devices, are actions in contravention of academic integrity.

LATE POLICY

Any applicable late penalties are described in the details for each assessment. In the event of extenuating circumstances, you must follow the policies for requesting an academic consideration (please see below). Note that unacceptable reasons include extra-curricular activities, travel plans, generally behind on schoolwork, etc. In the absence of an approved consideration request, the normal late penalty will apply as described in the assignment or any course/departmental policies.

INVALID EXAMS

An exam may be declared invalid in case of an interruption in an in-person examination; if the instructions in a remote or online exam were not followed; if the student uploads wrong materials; or if a situation arises where the integrity of the exam cannot be verified. If an exam is declared invalid, the student may be granted a re-write.

ABSENCES (ACADEMIC CONSIDERATIONS) AND ACADEMIC ACCOMMODATIONS

For absences and academic accommodations please review the information on the [FEAS website](#).

ACADEMIC AND STUDENT SUPPORT

Queen's has a robust set of supports available to you including the [Library](#), [Student Academic Success Services \(Learning Strategies and Writing Centre\)](#), and [Career Services](#). Learners are encouraged to visit the Faculty of Engineering and Applied Science [Current Students](#) web portal for information about various other policies such as academic advisors, registration, student exchanges, awards and scholarships, etc.

INDIVIDUAL NEEDS AND SUPPORT

If you have a disability or health-related condition that may require academic accommodations, please approach the [Queen's Accessibility Services](#). The staff at Accessibility Services are available by appointment to develop individualized accommodation plans, provide referrals, and assist with advocacy. The sooner you let us know your needs, the better we can assist you in

achieving your learning goals. For questions or assistance with requesting Academic Consideration or Accommodation, contact the FEAS Academic Accommodation Coordinator at engineering.aac@queensu.ca

Every effort has been made to provide course materials that are accessible. For further information on accessibility compliance of the educational technologies used in this course, please consult the links below.

| EDUCATIONAL TECHNOLOGY | ACCESSIBILITY COMPLIANCE INFORMATION |
|--|---|
| onQ (Brightspace Learning Management System by D2L) | https://www.d2l.com/accessibility/standards/ |
| Zoom | https://zoom.us/accessibility |

If you find any element of this course difficult to access, please discuss with your instructor how you can obtain an accommodation.

ACCOMMODATIONS RELATED TO REMOTE ASSESSMENT

To have your accommodations applied to a remote-proctored exam please follow the instructions for submitting your information, as outlined on the QSAS website. Your accommodations will be incorporated into your exam session by the Queen's University exam coordinators, on behalf of your course instructor. This information is uploaded automatically to [Proctortrack / Examity](#).

If you are already registered with QSAS and you require additional accommodations related to remote-proctored exams, please consult with your QSAS advisor to update your Letter of Accommodation as appropriate.

RELIGIOUS OBSERVANCE

Students in need of accommodation for religious observance are asked to speak to their professor within a week of receiving their syllabus. Note also that alternative assignments are considered a "reasonable accommodation" under the Ontario Human Rights Code. Students with questions about their rights and responsibilities regarding religious accommodation should contact Chaplain Kate Johnson via Chaplain@queensu.ca.

TECHNICAL SUPPORT

Some basic comfort level with basic hardware and software skills are required for this course. If you require technical assistance, please contact [Technical Support](#).

SUPPORTIVE PERSONAL COUNSELLING

If at any time you find yourself feeling overwhelmed, anxious, sad, lonely, or distressed, consider confidential supportive counselling offered by the [embedded counselors](#) at the Student Wellness Service Faculty of Engineering and Applied Science.

SUPPORTIVE PERSONAL COUNSELLING

If at any time you find yourself feeling overwhelmed, anxious, sad, lonely, or distressed, consider confidential supportive counselling offered by the [embedded counselors](#) and by Student Wellness Services <https://www.queensu.ca/studentwellness/>