MATS3004

Polymer Science and Engineering 1

Course Outline
Session 2, 2016
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Course staff

<table>
<thead>
<tr>
<th>Dr. Damia Mawad</th>
<th>Room 246, School of Materials Science and Engineering (Building E10)</th>
<th>Consultation hours: Fridays, 2-3 pm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Coordinator &amp; Lecturer</td>
<td>Phone: 9385 6642 [<a href="mailto:damia.mawad@unsw.edu.au">damia.mawad@unsw.edu.au</a>]</td>
<td></td>
</tr>
<tr>
<td>Dr. Pramod Koshy</td>
<td>Room 220, School of Materials Science and Engineering (Building E10)</td>
<td>Consultation hours: by appointment</td>
</tr>
<tr>
<td>Lecturer</td>
<td>Phone: 9385 6038 [<a href="mailto:koshy@unsw.edu.au">koshy@unsw.edu.au</a>]</td>
<td></td>
</tr>
</tbody>
</table>

Timetable

Lectures and Labs

<table>
<thead>
<tr>
<th>Day</th>
<th>Time</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuesday (Weeks 1-6)</td>
<td>11:00 – 13:00</td>
<td>ChemicalSc M17 (K-F10-M17)</td>
</tr>
<tr>
<td>Thursday (Weeks 1-6)</td>
<td>9:00 – 11:00</td>
<td>Colombo Theatre B (K-B16-LG04)</td>
</tr>
<tr>
<td>Tuesday (Weeks 7-12)</td>
<td>11:00 - 13:00</td>
<td>The Michael Hintze Theatre (K-H6-LG03)</td>
</tr>
<tr>
<td>Thursday (Weeks 7-12)</td>
<td>9:00 – 11:00</td>
<td>Rupert Myers Theatre (K-M15-1001)</td>
</tr>
</tbody>
</table>
## Your Course at a Glance
(Any changes will be advised in class or via Moodle)

<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Dr. Damia Mawad (DM)</th>
<th>Dr. Pramod Koshy (PK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Hours</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>Week No.</td>
<td>Tuesday (11:00-13:00)</td>
<td>Thursday (9:00-11:00)</td>
</tr>
<tr>
<td><strong>Week 1</strong></td>
<td>25 July 29 July</td>
<td></td>
</tr>
<tr>
<td>Introduction to Polymers</td>
<td>Morphology/Types of Polymers</td>
<td></td>
</tr>
<tr>
<td><strong>Week 2</strong></td>
<td>1 August 5 August</td>
<td></td>
</tr>
<tr>
<td>Radical Polymerization</td>
<td>Condensation / Ionic Polymerization</td>
<td></td>
</tr>
<tr>
<td><strong>Week 3</strong></td>
<td>8 August 12 August</td>
<td></td>
</tr>
<tr>
<td>Polymer Thermodynamics I</td>
<td>Polymer Thermodynamics II</td>
<td></td>
</tr>
<tr>
<td><strong>Week 4</strong></td>
<td>15 August 19 August</td>
<td></td>
</tr>
<tr>
<td>Characterization of Polymers: Polymers in Solutions</td>
<td>Characterization of Polymers: MW, Light Scattering</td>
<td></td>
</tr>
<tr>
<td><strong>Week 5</strong></td>
<td>22 August 26 August</td>
<td></td>
</tr>
<tr>
<td>Guest Lecture: Intro to Spectroscopy</td>
<td>Elastomers</td>
<td></td>
</tr>
<tr>
<td><strong>Week 6</strong></td>
<td>29 August 2 September</td>
<td></td>
</tr>
<tr>
<td>Revision</td>
<td>MID TERM EXAMINATION</td>
<td></td>
</tr>
<tr>
<td><strong>Week 7</strong></td>
<td>5 September 9 September</td>
<td></td>
</tr>
<tr>
<td>Amorphous Polymers</td>
<td>Crystalline Polymers</td>
<td></td>
</tr>
<tr>
<td><strong>Week 8</strong></td>
<td>12 September 16 September</td>
<td>Lab</td>
</tr>
<tr>
<td><strong>Week 9</strong></td>
<td>19 September 23 September</td>
<td>Lab</td>
</tr>
<tr>
<td><strong>MID-SESSION BREAK</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Week 10</strong></td>
<td>3 October 7 October</td>
<td>Lab</td>
</tr>
<tr>
<td><strong>Week 11</strong></td>
<td>10 October 14 October</td>
<td>Lab</td>
</tr>
<tr>
<td><strong>Week 12</strong></td>
<td>17 October 21 October</td>
<td>Commodity and Specialty Plastics</td>
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**FINAL EXAMINATION**
Course Objectives

This course is an introduction to the fundamentals of polymer science and engineering, covering the synthesis and characterisation of polymers, the relation between chemical structure and polymer morphology, mechanical, rheological, thermal and chemical properties and technological developments in commodity and advanced polymers.

The course objectives are:

1. To introduce the students to polymers, their synthesis, reaction mechanism and kinetics.

2. To provide the students with an understanding of polymer behaviour in the solid and solution state; as well as characterisation techniques commonly used in polymer science.

3. To provide the students with basic knowledge of the morphology of polymers in the solid state, amorphous and crystalline, and their thermal properties. Particular emphasis will be on the chemical structure of the polymer and its effect on the morphology.

4. To teach the students basic concepts related to mechanical/viscoelastic, chemical, electrical and optical properties of polymers.

5. To introduce polymer technology including processing, applications and manufacturing of commodity polymers.

Course Outline

The course is divided into 4 sections:

**Polymer Chemistry and Synthesis**: raw materials and synthesis of polymers; monomers, homopolymers, copolymers; basic organic chemistry and applied polymer chemistry; free radical polymerization, reaction and termination rates using physical chemistry models; ionic and condensation polymerization.

**Polymer Physics and Characterisation**: molecular statistics of rubbery states; chain branching, networking; iso-free volume theory; properties affected by primary bonds; physical properties affected by secondary bonds; polymer thermodynamics; polymer solution behaviour; characterisation techniques such as molecular weight determination or spectroscopy.

**Polymer morphology, viscoelasticity and properties**: amorphous and crystalline states; thermal properties; fundamental rheology; glassy and viscoelastic behaviour; effect of molecular weight, temperature and shear rate; structure-property correlation in glassy, semicrystalline and oriented polymers; free volume and fractal theories; tensile, shear, compression and impact properties; effect of temperature and strain rates; chemical, electrical, and optical properties.

**Commodity and specialty plastics**: compositions and fabrication; additives in plastics; commercial manufacturing processes and applications.
Assessment

<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Category</th>
<th>Marks</th>
<th>Due Date</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damia Mawad</td>
<td>Assignment 1</td>
<td>10</td>
<td>End of Week 3</td>
<td>Assignment/Quiz: A set of exercises to be solved</td>
</tr>
<tr>
<td>Damia Mawad</td>
<td>Assignment 2</td>
<td>10</td>
<td>End of Week 5</td>
<td>Individual Assignments: Provide a written report (approx. 1-2 pages including figures, tables, references) Topics will be related to subjects taught in class</td>
</tr>
<tr>
<td>Damia Mawad</td>
<td>Mid-term Examination</td>
<td>30</td>
<td>Week 6</td>
<td>Exam will be 2 hours in duration Topics taught by Dr. Mawad</td>
</tr>
<tr>
<td>Pramod Koshy</td>
<td>Individual Assignments (2)</td>
<td>10</td>
<td>To be decided</td>
<td>Individual Assignments: Provide a written report (approx. 1-2 pages including figures, tables, references) Topics will be related to subjects taught in class</td>
</tr>
<tr>
<td>Pramod Koshy</td>
<td>Laboratory (Group Assignment)</td>
<td>10</td>
<td>Week 13</td>
<td>Laboratory activities will involve use of FTIR, Raman, NMR, XRD, DSC for analysis of polymers, as well as injection/compression moulding for polymer fabrication Results and discussion of these labs to be compiled into a single report</td>
</tr>
<tr>
<td>Pramod Koshy</td>
<td>Final Examination</td>
<td>30</td>
<td>Examination Period</td>
<td>Exam will be 2 hours in duration Topics taught by Dr. Koshy</td>
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*Note: Students who fail to score at least 50% for the overall exam component (i.e., mid-term exam and final exam marks combined), but achieve a final mark > 50% for the course, may still be awarded a UF (Unsatisfactory Fail) for the course. Please refer to the UNSW guide to grades: https://student.unsw.edu.au/grades*

**Recommended Textbook**:  

**References**:  

In addition, notes and selected reference material will be issued in lectures.

* Assistance is available from the Library:
  info.library.unsw.edu.au/web/services/teaching.html

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**Learning and teaching philosophy underpinning the course**

*Based on UNSW Learning Guidelines*

The course is designed for students to actively engage in the learning process and analyse and synthesise the content in a real world environment.

- **Students are engaged actively in the learning process.**
  It is expected that, in addition to attending classes, students will read, write, discuss, and engage in analysing the course content.

- **Effective learning is supported by a climate of inquiry, where students feel appropriately challenged.**
  Students are expected to be challenged by the course content and to challenge their own preconceptions, knowledge, and understanding by questioning information, concepts, and approaches during class and study.

- **Learning is more effective when students’ prior experience and knowledge are recognised and built on.**
  Coursework, tutorials, assignments, laboratories, examinations, and other forms of learning and assessment are intended to provide students with the opportunity to cross-reference these activities in a meaningful way with their own experience and knowledge.

- **Students become more engaged in the learning process if they can see the relevance of their studies to professional and disciplinary contexts.**
  The course content is designed to incorporate both theoretical and practical concepts, where the latter is intended to be applicable to real-world situations and contexts.
# Course Information

<table>
<thead>
<tr>
<th>Units of credit</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>How the course relates to other course offerings and overall program(s) in the discipline</td>
<td>The course is a core course in the Materials Engineering BE program. It introduces fundamentals of polymer science and engineering, covering the synthesis and characterisation of polymers, the relation between chemical structure and polymer morphology, mechanical and rheological properties, and technological developments in commodity and advanced polymers. The course utilizes knowledge and experience from previously studied courses in the BE program including chemistry, mathematics, physical properties of materials, materials characterization, mechanical behavior of materials, fluid flow and heat transfer, thermodynamics and phase equilibria.</td>
</tr>
</tbody>
</table>

## Graduate attributes which will be gained through the course

- Ability to communicate effectively
- Capacity for creativity and innovation
- Ability to manage information and documentation
- Understanding of professional and ethical responsibilities, and commitment to them
- Ability to function effectively as an individual
- Ability to work effectively in multidisciplinary and multicultural teams
- Capacity for lifelong learning and professional development
- Professional attitudes

## Expected learning outcomes

In doing this course, you will learn to:

- use fundamental polymer chemistry to explain and predict the synthesis of polymers and plastics as well as the resultant structure and properties
- predict/interpret the behaviour and properties of plastics as a function of their composition and manufacturing conditions
- solve problems, perform calculations, and undertake design in the area of polymer synthesis and processing
- select plastics and elastomers for engineering and technological applications
- evaluate technological developments in commodity and advanced polymers

You will also learn to:

- Think critically in decision making and problem-solving
- Communicate with correct terminology
- Conduct online research
- Work effectively in a team to solve problems

## Teaching strategies

- Core concepts, theories and approaches will be covered in lectures.
- These concepts will be reinforced in a practical context in the laboratory sessions.
- Extensive use will be made of case studies to exemplify polymer synthesis and microstructure–property relationships
- Real-life examples and recent developments in polymer synthesis and manufacturing will be examined in the assignments
- Teaching material, including course outline, lecture notes, assignments, case studies and course announcements are available on the Course Blackboard website.

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1. Based on the professional attributes given in Engineers Australia National Generic Competency Standards - Stage 1 Competency Standard for Professional Engineers and UNSW Graduate Attributes.
Academic honesty and plagiarism

What is Plagiarism?
Plagiarism is the presentation of the thoughts or work of another as one’s own.* Examples include:
• direct duplication of the thoughts or work of another, including by copying material, ideas or concepts from a book, article, report or other written document (whether published or unpublished), composition, artwork, design, drawing, circuitry, computer program or software, web site, Internet, other electronic resource, or another person’s assignment without appropriate acknowledgement;
• paraphrasing another person’s work with very minor changes keeping the meaning, form and/or progression of ideas of the original;
• piecing together sections of the work of others into a new whole;
• presenting an assessment item as independent work when it has been produced in whole or part in collusion with other people, for example, another student or a tutor; and
• claiming credit for a proportion a work contributed to a group assessment item that is greater than that actually contributed.†

For the purposes of this policy, submitting an assessment item that has already been submitted for academic credit elsewhere may be considered plagiarism.

Knowingly permitting your work to be copied by another student may also be considered to be plagiarism.

Note that an assessment item produced in oral, not written, form, or involving live presentation, may similarly contain plagiarised material.

The inclusion of the thoughts or work of another with attribution appropriate to the academic discipline does not amount to plagiarism.

The Learning Centre website is main repository for resources for staff and students on plagiarism and academic honesty. These resources can be located via:

www.lc.unsw.edu.au/plagiarism

The Learning Centre also provides substantial educational written materials, workshops, and tutorials to aid students, for example, in:
• correct referencing practices;
• paraphrasing, summarising, essay writing, and time management;
• appropriate use of, and attribution for, a range of materials including text, images, formulae and concepts.

Individual assistance is available on request from The Learning Centre.

Students are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting, and the proper referencing of sources in preparing all assessment items.

* Based on that proposed to the University of Newcastle by the St James Ethics Centre. Used with kind permission from the University of Newcastle
† Adapted with kind permission from the University of Melbourne.
Continual course improvement

- Students will be asked to provide evaluative feedback through the UNSW's Course and Teaching Evaluation and Improvement (CATEI) process at the end of the course.
- Students are encouraged to address any problems regarding teaching of this course at the annual staff-student meeting.
- Student comments on teaching during the session are welcome and will be appreciated. At times students may be asked to answer a short questionnaire for feedback on the course.

Administrative Matters

- Students should attend at least 80% of all classes.
- Students unable to submit assignments on time or attend the mid-session quizzes or final exams on health grounds should make a request for special consideration. Information on this process can be found here [https://my.unsw.edu.au/student/atoz/SpecialConsideration.html](https://my.unsw.edu.au/student/atoz/SpecialConsideration.html). Medical certificates or other appropriate documents must be included. Students should also advise the lecturer of the situation.
- Assignments/lab reports submitted after the deadline will receive a 10% of maximum grade penalty for every day late, or part thereof.
- Students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course coordinator prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equity and Diversity Unit (www.studentequity.unsw.edu.au). Early notification is essential to enable any necessary adjustments to be made.

Rules for Exams


Note that the use of mobile phones or music players in an exam room will constitute Academic Misconduct.