MATLS 4T03/6T03: Properties and Processing of Composites

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Office Hours: TBD

CALENDAR DESCRIPTION:

Intrinsic properties of matrix materials and fibres; mechanics and thermodynamics of interfaces; mechanical properties and fabrication of engineering composites.

COURSE TOPICS:

The concepts covered in this course include:

1. An introduction to composites materials (chapter 1, 2, 3)
2. An introduction to tensors, stress, strain and elasticity theory (chapter 4, 5, 6)
3. Elastic behaviour of continuous fibre composites (ch. 4, 5)
4. Elastic behaviour of short fibre composites (ch. 6)
5. A description of the nature and importance of interfaces (ch 7)
6. Fracture strength of composites (ch. 8)
7. Fracture toughness of composites (ch. 9)
8. Thermal behaviour and creep (ch. 10)
9. Plastic deformation of composite materials
10. Expanding to other properties of composite materials
11. New types of composite materials: Functionally Graded and Architectured Materials
12. Fabrication routes of composite materials (ch 11).

COURSE_REFERENCE MATERIAL:

Primary text book:


Supplementary texts:
S. Suresh and A. Mortensen, Fundamentals of Functionally Graded Materials
K.K. Chawla, Composite Materials
A. Kelly and N. H. MacMillan, Strong Solids
F. A. McClintock and A. S. Argon, Mechanical Behaviour of Materials
R. J. Young and P. A. Lovell, Introduction to Polymers
M.R. Piggott, Load Bearing Fibre Composites (not in library, I have a copy)
M.F. Ashby and D.R.H. Jones, Engineering Materials 2
L. Gibson and M.F. Ashby, Cellular Solids
T.W. Clyne and P. J. Withers, Introduction to Metal Matrix Composites
A. Kelly, Fabrication of Composites
A. Kelly and G.W.Groves, Crystallography and Crystal Defects.

**EVALUATION:**

<table>
<thead>
<tr>
<th>Weekly quizzes</th>
<th>10%</th>
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<tbody>
<tr>
<td>Test 1</td>
<td>20%</td>
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<td>Test 2</td>
<td>20%</td>
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<tr>
<td>Group project &amp; presentation (4-5 students/group):</td>
<td>20%</td>
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<td>Final exam:</td>
<td>30%</td>
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Final group project will involve the following elements:

- pick an application for which composites are a likely candidate
- develop in depth report which addresses:
  - possible materials systems
  - rational selection of materials
  - detailed design of composite architecture
  - analysis of micro-mechanics including (if important): elasticity limits, fracture toughness properties, fatigue properties, fracture, etc...

Projects will be presented orally and in written form and it should be optimized for the presentation of about 20 minutes. There will be six groups of 4-5 students per group. Team work will be judged as well. You team mark will be multiplied by a “participation factor” for each team member in order to arrive at the final mark of each student.

**COURSE OBJECTIVES:**

At the conclusion of this course, the student should have:
1. Develop knowledge of:

- Composite materials - what are they and how do they differ from other classes of materials?
- Nature of reinforcing materials - fibres, whiskers, platelets, etc.
- Overview of mechanical and physical properties of a range of composite materials systems
- Mechanisms of composite deformation and fracture
- Fabrication of composite materials, and how this relates to microstructure and properties
- How new materials are developed and become accepted by industry

2. Develop skills in:

- Assessment of the applicability of a specific material for a specific application
- Rational selection of materials
- Mechanics analysis of composite materials
- Self-directed learning, incorporating researching properties of commercial materials
- Reporting and presentation of information
- Industrial/manufacturing approach to applying technical knowledge

**RELEVANCE TO OTHER COURSES:**

This course can be considered a capstone experience in that it allows the student to apply much of the knowledge gained in previous course related to solid mechanics, mechanical behaviour of materials, microstructure and processing.

**POLICY REMINDERS:**

The Faculty of Engineering is concerned with ensuring an environment that is free of all adverse discrimination. If there is a problem that cannot be resolved by discussion among the persons involved, individual are reminded that they should contact the Department Chair, the Sexual Harassment Office or the Human Rights Consultant, as soon as possible.

The Senate Resolution on Course Outlines states that:

“Students should be reminded that they should read and comply with the "Statement on Academic Ethics and the Senate Resolution on Academic Dishonesty" as found in the Senate Policy Statements distributed at registration and available in the
Senate Office”.

Academic dishonesty consists of misrepresentation by deception or by other fraudulent means and can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various kinds of academic dishonesty please refer to the Academic Integrity Policy, specifically Appendix 3, located at: http://www.mcmaster.ca/senate/academic/ac_integrity.htm

The following illustrates only three forms of academic dishonesty:

- Plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.

- Improper collaboration in group work.

- Copying or using unauthorized aids in tests and examinations.

ACCESSIBILITY:

McMaster University is committed to fostering, creating and maintaining a barrier-free environment for all individuals providing equal rights and opportunities, including:

- Promoting a respectful attitude for persons with disabilities;
- Promoting awareness of the needs and abilities of persons with disabilities;
- Informing the University community about the services available to persons with disabilities and seeking to ensure that such services are delivered in ways that promote equity; and
- Providing support services, subject to certain limitations.

Students requiring service or accommodation contact Student Accessibility Services (SAS): http://sas.mcmaster.ca/ as soon as possible.

For more information, please visit http://mcmaster.ca/policy/Students-AcademicStudies/
DISCLAIMER:

"The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes."

Completed by Florent Lefevre-Schlick on January 5, 2018