ENGG*2120 Material Science

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Winter 2021
Section(s): C01

School of Engineering
Credit Weight: 0.50
Version 1.00 - January 08, 2021

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1 Course Details

1.1 Calendar Description

Study of the mechanical, electrical, magnetic, optical and thermal properties of solids. Atomic order and disorder in solids, single-phase metals, and multiphase materials (their equilibria and micro-structure) are examined as a basis for understanding the causes of material properties. Interwoven throughout the course is an introduction to materials selection and design considerations.

Pre-Requisites: CHEM*1040, PHYS*1130

1.2 Timetable

Lectures:

Section 1

Tuesday & Thursday	10:00 AM – 11:20 AM	Zoom through Courselink

Laboratory: Materials Science Lab

Sec 1	Monday	12:30 PM - 2:20 PM	Virtual
Sec 2	Monday	3:30 PM - 5:20 PM	Virtual

Sec 3	Thursday	1:00 PM - 2:50 PM	Virtual
Sec 4	Wednesday	3:30 PM - 5:20 PM	Virtual

1.3 Final Exam

Friday, April 16th, 2021 7:00 PM - 9:00 PM

Final exam date, time and location is set by the University Registrar.

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2 Instructional Support

2.1 Instructional Support Team

Instructor: Ryan Clemmer
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Lab Technician: Barry Verspagen
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2.2 Teaching Assistants

Teaching Assistant: Mateo Gonzalez de Gortari
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Teaching Assistant: Stephanie Kotiadis
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Teaching Assistant: Benjamin Snow
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Office Hours: Email for appointment

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3 Learning Resources

3.1 Required Resources

D.R. Askeland and W.J. Wright, The Science and Engineering of Materials, 7th Edition, SI, Cengage Learning, 2016 (Textbook)

Courselink (Website)
https://courselink.uoguelph.ca
Course material, news, announcements, and grades will be regularly posted to the ENGG*2120 Courselink site. **You are responsible for checking the site regularly.**

3.2 Recommended Resources

W.D. Callister and D.G. Rethwisch, Materials Science and Engineering: An Introduction, 9th Edition, John Wiley & Sons, Inc., 2014. (Textbook)

3.3 Additional Resources

Lecture Information: Lecture notes will be posted on Courselink.

Please note that PowerPoint presentations are not comprehensive of all materials covered. During lecture, additional notes and examples may be provided.

Lab Information: The lab manual and schedule for the laboratory exercises are posted on Courselink. Be sure to read the appropriate lab instructions prior to the lab demonstration.

Assignments: Study assignments will be posted at the end of a chapter or a group of chapters, with the solutions to follow about one week later. Assignments will not be marked. It is strongly recommended that you work through these assignments as they are valuable study aids and similar to the types of questions that may be asked on an exam.

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4 Learning Outcomes

This course is an introductory course in materials science. The student will be introduced to the atomic or molecular structure of metals, polymers, ceramics, and composite materials and learn how these different structures influence their mechanical, electrical and thermal behaviour. Many of the differences between properties of classes of materials are related to the atomic structure of the material.

The mechanical properties of a material are influenced by the atomic arrangement and presence of crystallographic defects. In addition, methods of controlling the atomic arrangement of a material such as heat treating and strain hardening will be investigated. Finally, common service failures due to creep, fatigue, or fast fracture will be examined in light of the atomic structure of the different materials.

The course will also examine material consideration for design. Each material has its own unique properties and characteristics. Understanding how the material properties can change with the environment and how the properties can be manipulated will provide more informed material selection choices. A properly selected material can enhance a design through structural changes and greater performance while an improperly selected material can lead to complete design failure.

4.1 Course Learning Outcomes

By the end of this course, you should be able to:

1. Describe the general properties of key engineering materials: metals, semiconductors, ceramics, polymers, and composites through a material identification project
2. Create simple lab experiments to measure material properties and evaluate the effectiveness of the experiment in measuring those properties through a material identification project
3. Recognize the concepts of stress, strain and how they are related, and determine the elastic modulus, the yield strength, the tensile strength and the ductility for a given engineering stress-strain curve.
4. Recognize the link between atomic structure of a material and its macroscopic properties through testing of material properties such as strength, stiffness, and impact behaviour
5. Explain how the microstructure of a material can be manipulated by altering the operating environment, strain hardening, and heat treatment through lab report discussion questions
6. Derive the relationships between unit cell edge length and atomic radius for FCC, BCC and HCP crystal structures.
7. Compare measured material properties such as compressive strength, tensile strength, and elastic modulus with the expected theoretical results and explain discrepancies through lab report discussions
8. Determine the phases present, the compositions of the phases, and the mass fractions of the phases for some given phase diagrams through practice problems and exams
9. Select an appropriate material for a given application based on knowledge of material properties through class examples, exams, and lab reports
10. Present, analyze, and discuss experimental data through well written lab reports

4.2 Engineers Canada - Graduate Attributes (2018)

Successfully completing this course will contribute to the following:

#	Outcome	Learning Outcome
1	Knowledge Base	1, 3, 4, 5, 7, 8, 9
1.2	Recall, describe and apply fundamental principles and concepts in natural science	1, 3, 4, 5, 7, 8, 9

#	Outcome	Learning Outcome
1.3	Recall, describe and apply fundamental engineering principles and concepts	1, 3, 4, 5, 7, 8, 9
3	Investigation	2, 7, 10
3.1	Propose a working hypothesis	2, 10
3.2	Design and apply an experimental plan/investigative approach (for example, to characterize, test or troubleshoot a system)	2, 10
3.3	Analyze and interpret experimental data	2, 7, 10
3.4	Assess validity of conclusions within limitations of data and methodologies	2, 7, 10
5	Use of Engineering Tools	2, 7
5.1	Select appropriate engineering tools from various alternatives	2
5.2	Demonstrate proficiency in the application of selected engineering tools	2
5.3	Recognize limitations of selected engineering tools	2, 7
7	Communication Skills	2, 10
7.1	Identify key message(s) and intended audience in verbal or written communication as both sender and receiver	10
7.2	Interpret technical documentation such as device specification sheets, drawings, diagrams, flowcharts, and pseudocode	10
7.3	Construct the finished elements using accepted norms in English, graphical standards, and engineering conventions, as appropriate for the message and audience	2, 10
7.4	Substantiate claims by building evidence-based arguments and integrating effective figures, tables, equations, and/or references	2, 10
7.5	Demonstrate ability to process oral and written communication by following instructions, actively listening, incorporating feedback, and formulating meaningful questions	10

5 Teaching and Learning Activities

Please note that the order of topics is tentative and may be adjusted at the discretion of the instructor.

5.1 Lecture

Topics:	Introduction
References:	Chapter 1
Topics:	Mechanical Properties
References:	Chapter 6
Topics:	Failure Mechanisms
References:	Chapter 7
Topics:	Atomic Structure
References:	Chapter 2
Topics:	Atomic Arrangement
References:	Chapter 3
Topics:	Imperfections in Atomic Arrangement
References:	Chapter 4
Topics:	Ferrous & Non-Ferrous Alloys
References:	Chapter 13, 14
Topics:	Ceramics
References:	Chapter 15
Topics:	Polymers
References:	Chapter 16
Topics:	Composites
References:	Chapter 17
Topics:	Solid Solutions
References:	Chapter 10
Topics:	Dispersion Strengthening - Phase Diagrams
References:	Chapter 11
Topics:	Dispersion Strengthening - Phase Transformations
References:	Chapter 12
Topics:	Heat Treating of Steel
References:	Chapter 13
Topics:	Strain Hardening
References:	Chapter 8
Topics:	Semiconductors
References:	Chapter 19

5.2 Lab Schedule

A lab schedule is posted on Courselink. The schedule provides information on groups, experiments and the project. All lab reports must be submitted electronically in the dropbox

on Courselink for marking by 8:00 PM on the day the report is due. For the weeks students are not in the lab, they are expected to be writing their lab report, or preparing for their next lab exercise. GTAs will be available during the lab time to answer questions.

A video demonstration and data for each lab exercise will be posted on Courselink. A GTA will be available during the lab time when a lab demonstration is scheduled to review the video demonstration.

Lab Activity	Lab Demonstration	Report Due Date
Material Identification Project	Posted on Courselink	Feb 3 - 8:00 PM
Lab Group Formation	Jan 18 - Jan 21	Jan 22 - 8:00 PM
Compressive Testing of Materials	Jan 25 - Jan 28	Feb 12 - 8:00 PM
Tensile Testing of Materials	Feb 8 - Feb 11	Mar 5 - 8:00 PM
Impact Testing of Materials	Mar 8 - Mar 11	Mar 26 - 8:00 PM
Heat Treating of Metals	Mar 22 - Mar 25	Apr 9 - 8:00 PM

5.3 Other Important Dates

- **Monday, January 11, 2021:** First day of class
- **Monday, February 15, 2021 to Friday, February 19, 2021:** Winter break, No Classes
- **Friday, April 2, 2021:** Holiday - No classes
- **Monday, April 12, 2021:** Last day of classes (Friday Schedule)

See Schedule of Dates for other important dates in the academic year.
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c03/c03-wintersem.shtml

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6 Assessments

Passing grade: An overall final grade of 50% is required to pass the course.

6.1 Marking Schemes & Distributions

The final grade will be the better of Marking Scheme A or Marking Scheme B.

Name	Scheme A (%)	Scheme B (%)
Materials Project	10	10
Lab Reports	20	20
Midterm	25	30
Final Exam	45	40
Total	100	100

6.2 Assessment Details

Assignments (0%)
Learning Outcome: 3, 6, 7, 8
Study assignments will be posted at the end of a chapter or a group of chapters, with the solutions to follow about one week later. Assignments will not be marked. It is strongly recommended that you work through these assignments as they are valuable study aids and similar to the types of questions that may be asked on an exam.

Materials Identification Project (10%)
Learning Outcome: 1, 2, 4, 5, 7, 9, 10
The Materials Identification project report is due Wednesday, February 3rd at 8 PM

Lab Reports (20%)
Date: THRN 1008
Learning Outcome: 4, 5, 7, 9, 10
For lab report due dates, please refer to the activities schedule section of the course outline.

Midterm (25%)
Date: March 9, 2021 in class, Online
Learning Outcome: 1, 4, 9
The midterm will be open-book. Students are allowed to use their own digital or handwritten notes and course materials posted on Courselink. Use of additional websites, third-party student learning support services and communication with others is prohibited. There is no collaboration allowed.

Final Exam (45%)
Date: Fri, Apr 16, 7:00 PM - 9:00 PM, Online
Learning Outcome: 1, 4, 5, 8, 9
Final Exam date, time and location is set by the University Registrar.

The final will be open-book. Students are allowed to use their own digital or handwritten notes and course materials posted on Courselink. Use of additional websites, third-party student learning support services and communication with others is prohibited. There is

no collaboration allowed.

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7 Course Statements

7.1 Introduction

1. Sharing of calculators, formula sheets, if applicable, or use of smart phones as calculators is not allowed.
2. Grading is based on the procedure, correctness of numerical calculations and final answer.
3. The instructor, at his discretion, may entertain requests by the class to adjust assessment dates, except final exam, with the unanimous consent of the class.
4. Check your lab section. *You are only allowed to attended the section you are registered in.*

7.2 Grading Policies

Missed Assessments: If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please email the course instructor **prior** to the assessment. See the undergraduate calendar for information on regulations and procedures for Academic Consideration: http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

Accommodation of Religious Obligations: If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within the **first two weeks** of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Accommodation of Religious Obligations: http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml

Passing Grade: An overall final grade of 50% is required to pass the course.

Missed Midterm Exams: If you miss the midterm due to grounds for granting academic consideration or religious accommodation, the weight of the missed midtermt will be added to the final exam. There will be no makeup midterm exams.

Remarking of Midterm Exam: Consideration for remarking of the midterm exam will only be allowed if brought to the attention of the instructor within two weeks of when midterm results are released.

Lab Work: The laboratory work is group based. You will need to organize yourselves into groups of three (3) or four (4) within your lab section by Friday, January 22nd. Be sure to choose your lab partners wisely!

Each group will be responsible for completing the labs and writing a single report for each lab. You will be equally responsible for your group's laboratory reports. Each group member must make a significant contribution to the writing of the lab report and sign the lab report cover page in order to receive a lab report mark. The marks for the lab reports will be posted on Courselink. Lab reports will be evaluated based on the quality of the entire report, and not the performance of individuals. Individuals may have their grade reduced if their contribution to the report is deemed unsatisfactory. Any reports judged to be entirely unacceptable will be returned without marking for rewriting. If you have questions about your mark, see the GTA responsible for that lab and they will discuss it with you. Contact the instructor if any major issues with your lab group arise.

Late Lab Reports: There will be a late penalty of 20%/day or part thereof for any late lab reports. That is, reports submitted within 24 hours after the initial due date will lose 20%, reports submitted between 24 and 48 hours after the initial due date will lose 40%, and so on. Lab reports are considered late if they are submitted after the specified time they are due.

8 School of Engineering Statements

8.1 Instructor's Role and Responsibility to Students

The instructor's role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on Courselink but these are not intended to be stand-alone course notes. Some written lecture notes will be presented only in class. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests and labs.

8.2 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and lab sessions. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

8.3 Lab Safety

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible.

9 University Statements

9.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

9.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

Graduate Calendar - Grounds for Academic Consideration
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions
https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml

9.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml

Graduate Calendar - Registration Changes
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml

Associate Diploma Calendar - Dropping Courses
https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml

9.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

9.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to book their exams at least 7 days in advance and not later than the 40th Class Day.

For Guelph students, information can be found on the SAS website
https://www.uoguelph.ca/sas

For Ridgetown students, information can be found on the Ridgetown SAS website
https://www.ridgetownc.com/services/accessibilityservices.cfm

9.6 Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity, and it is the responsibility of all members of the University community-faculty, staff, and students-to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff, and students have the responsibility of supporting an environment that encourages academic integrity. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

Undergraduate Calendar - Academic Misconduct
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml

Graduate Calendar - Academic Misconduct
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml

9.7 Recording of Materials

Presentations that are made in relation to course work - including lectures - cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

9.8 Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs.

Academic Calendars
https://www.uoguelph.ca/academics/calendars

9.9 Disclaimer

Please note that the ongoing COVID-19 pandemic may necessitate a revision of the format of course offerings and academic schedules. Any such changes will be announced via CourseLink and/or class email. All University-wide decisions will be posted on the COVID-19 website (https://news.uoguelph.ca/2019-novel-coronavirus-information/) and circulated by email.

9.10 Illness

The University will not normally require verification of illness (doctor's notes) for fall 2020 or winter 2021 semester courses. However, requests for Academic Consideration may still require medical documentation as appropriate.
