ENGG*2120 Material Science

Fall 2017

Sections(s): C01

School of Engineering

Credit Weight: 0.50

Version 1.00 - September 05, 2017

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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-Requisite(s): CHEM*1040, PHYS*1130

1.2 Timetable

Lectures:

Tuesday	11:30AM – 12:50PM	THRN 1200
Thursday	11:30AM – 12:50PM	THRN 1200

Laboratory:

Monday	Sec 01	1:30 PM - 3:20PM	THRN 1008
Monday	Sec 02	3:30 PM - 5:20 PM	THRN 1008
Tuesday	Sec 03	1:30 PM - 3:20PM	THRN 1008

Tuesday	Sec 04	3:30 PM - 5:20 PM	THRN 1008
Wednesday	Sec 05	1:30 PM - 3:20PM	THRN 1008
Wednesday	Sec 06	3:30 PM - 5:20 PM	THRN 1008
Thursday	Sec 11	8:30 AM - 10:20 AM	THRN 1008
Thursday	Sec 07	1:30 PM - 3:20PM	THRN 1008
Thursday	Sec 08	3:30 PM - 5:20 PM	THRN 1008
Friday	Sec 09	1:30 PM - 3:20PM	THRN 1008
Friday	Sec 10	3:30 PM - 5:20 PM	THRN 1008

1.3 Final Exam

Thursday, December 14, 11:30 AM - 1:30 PM, Room: TBA

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2 Instructional Support

2.1 Instructor(s)

Ryan Clemmer PEng

Email:	rclemmer@uoguelph.ca
Telephone:	+1-519-824-4120 x52132
Office:	THRN 1337
Office Hours:	Wednesdays 10:30AM - 12:00PM or drop-in as needed

2.2 Instructional Support Team

Lab Technician:	Barry Verspagen
Email:	baverspa@uoguelph.ca
Telephone:	+1-519-824-4120 x58821
Office:	THRN 1138

2.3 Teaching Assistant(s)

Name	Details
Han Chen	hchen01@uoguelph.ca By appointment
Abdelkrem Eltaggaz	aeltagga@uoguelph.ca By appointment
Fatima Haque	fhaque@uoguelph.ca By appointment
Pragyan Garnaik	pgarnaik@uoguelph.ca By appointment
Oscar Valerio Gonzalez	ovalerio@uoguelph.ca By appointment
Gurvinder Mundi	gmundi@uoguelph.ca +1-519-824-4120 x58047 THRN 3106 By appointment

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3 Learning Resources

3.1 Required Resources(s)

D.R. Askeland, and W.J. Wright, The Science and Engineering of Materials, 7th Edition, SI, Cengage Learning, 2015. (Textbook)

I clickers for quizzes (Equipment)

>I clickers required for in-class quizzes.

3.2 Recommended Resources(s)

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: An incomplete set of lecture notes will be posted on Courselink prior to lecture.

During lecture, additional notes and examples will be provided. It is expected that you will have a copy of the posted lecture notes for each class.

Lab Information: The lab manual and schedule for the laboratory exercises are posted on Courselink.

Be sure to read the appropriate lab section prior to attending the lab.

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.

Exams: Some midterms and finals of previous years are posted as samples of exams. The solutions will also be posted for your convenience.

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4 Learning Outcomes

There are two main aspects to design: physical structure and material selection. 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.

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.There are two main aspects to design: physical structure and material selection. 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.

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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. Recognize the link between the atomic structure of a material and its macroscopic properties through testing of material properties such as strength, stiffness, and impact behaviour
3. 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
4. Compare measured material properties such as compressive strength, tensile strength, and elastic modulus with the expected theoretical results and explain discrepancies through lab report discus
5. Read and interpret phase diagrams through practice problems, quizzes, and exams
6. Create simple lab experiments to measure material properties and evaluate the effectiveness of the experiment in measuring those properties through a material identification project
7. Select an appropriate material for a given application based on knowledge of material properties through class examples, exams, and lab report discussion
8. Present, analyze, and discuss experimental data through well written lab reports

4.2 Engineers Canada - Graduate Attributes

Successfully completing this course will contribute to the following:

#	Outcome Set Name	Course Learning Outcome
1	Knowledge base	1, 2, 3, 5, 7
1.2	Recall, describe and apply fundamental concepts and principles in natural sciences	1, 2, 3, 5, 7
1.3	Comprehend and apply fundamental engineering concepts	1, 2, 3, 5, 7
3	Investigation	4, 6, 8
3.1	Propose and test working hypotheses	4, 6, 8
3.2	Design and apply an investigation plan	4, 6, 8
3.3	Analyze and interpret experimental data	4, 6, 8
3.4	Assess validity of conclusions within limitations of data and methodologies	4, 6, 8
5	Use of engineering tools	4, 6
5.1	Select appropriate engineering tools from various alternatives	4, 6
5.2	Apply selected engineering tools	4, 6
5.3	Recognize limitations of selected engineering tools	4, 6
7	Communication skills	6, 8
7.1	Develop and deliver clear, key concepts using methods appropriate for	6, 8

#	Outcome Set Name	Course Learning Outcome
	the intended audience	
7.2	Critically evaluate received information	6, 8
7.3	Demonstrate active listening and follow instructions	6, 8

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5 Teaching and Learning Activities

5.1 Lecture Schedule

Date	Topics(s)	References
Lecture 1	Introduction	Chapter 1
Lecture 2, 3	Mechanical Properties	Chapter 6
Lecture 4, 5	Failure Mechanisms	Chapter 7
Lecture 6	Atomic Structure	Chapter 2
Lecture 7	Ferrous & Non-Ferrous Alloys	Chapter 13, 14
Lecture 8	Ceramics	Chapter 15
Lecture 9, 10	Polymers	Chapter 16
Lecture 11	Composites	Chapter 17
Lecture 12, 13	Atomic Arrangement	Chapter 3
Lecture 14, 15	Imperfections in Atomic Arrangement	Chapter 4
Lecture 16	Semiconductors	Chapter 19
Lecture 17, 18	Solid Solutions	Chapter 10
Lecture 19, 20	Dispersion Strengthening - Phase Diagrams	Chapter 11
Lecture 21, 22	Dispersion Strengthening - Phase Transformations	Chapter 12
Lecture 23	Heat Treating of Steel	Chapter 13
Lecture 24	Strain Hardening	Chapter 8

5.2 Lab Schedule

A detailed lab schedule will be posted on Courselink. The table below summarizes when the labs are performed and when the corresponding reports are due. All lab reports must be submitted electronically in the dropbox on Courselink for marking by 4:00 PM **two weeks** after the laboratory is performed (unless indicated otherwise below). 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.

Lab	Groups (for all sections)	Lab Performed	Report Due Date
Lab Safety and Project Introduction	1-4	Sep 11 – Sep 15	
	5-8	Sep 11 – Sep 15	
Project Testing	1-4	Sep 18 – Sep 22	Oct 2 – Oct 6
	5-8	Sep 18 – Sep 22	Oct 2 – Oct 6
Compressive Testing of Materials	1-4	Sep 25 – Sep 29	Oct 16 – Oct 20
	5-8	Sep 25 – Sep 29	Oct 16 – Oct 20
Tensile Testing of Materials	1-4	Oct 16 – Oct 20	Oct 30 – Nov 3
	5-8	Oct 23 – Oct 27	Nov 6 – Nov 10
Midterm Review	1-4	Oct 16 – Oct 20	Midterm Oct 24
	5-8	Oct 16 – Oct 20	Midterm Oct 24
Impact Testing of Metals	1-4	Oct 30 – Nov 3	Nov 13 – Nov 17
	5-8	Oct 30 – Nov 3	Nov 13 – Nov 17
Heat Treatment of Metals	1-4	Nov 6 – Nov 10	Nov 20 – Nov 24
	5-8	Nov 13 – Nov 17	Nov 27 – Dec 1

5.3 Other Important Dates

- Thursday, September 7, 2017: First day of class
- Monday, October 9, 2017 Holiday: No classes scheduled
- Tuesday, October 10, 2017: Fall Study Break Day – No classes scheduled
- Friday, November 3, 2017: 40th class day, last day to drop
- Friday, December 1, 2017: Last day of class

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6 Assessments

6.1 Marking Schemes & Distributions

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

The best 5 of 7 Quizzes will be used to calculate the overall Quiz grade.

Passing grade: Students must achieve at least 50% of the marks assigned to the midterm and final exams in order for the labs and quizzes to be counted in the final grade. If you do not achieve at least 50% of the marks assigned to the midterm and final exams, the weighting of the lab reports and quizzes in your final grade will be zero. An overall final grade of 50% is required to pass the course.

Name	Scheme A (%)	Scheme B (%)
Quizzes	10.00	0.00
Project	5.00	5.00
Labs	20.00	20.00
Midterm	25.00	30.00
Final Exam	40.00	45.00
Total	100.00	100.00

6.2 Assessment Details

Quizzes

Date: , THRN 1200

The best 5 of 7 quizzes will be used to determine the overall quiz grade.

There will be several i>clicker quizzes during the lectures throughout the semester as scheduled. The quizzes are intended to help you better understand the course content and account for 10% of the course marks. Students are required to be present and use their own i>clicker during these quizzes. Impersonating a fellow student by using a clicker upon another student's behalf is an academic offense. Prior to the first quiz, you must register your i>clicker serial number through the following link:

https://www.uoguelph.ca/courselink/widgets/clickers/

Quiz 1

Date: Thursday, September 21, THRN 1200

Quiz 2

Date: Tuesday, October 3, THRN 1200

Quiz 3

Date: Thursday, October 19, THRN 1200

Quiz 4

Date: Tuesday, October 31, THRN 1200

Quiz 5

Date: Thursday, November 9, THRN 1200

Quiz 6

Date: Tuesday, November 21, THRN 1200

Quiz 7

Date: Thursday, November 30, THRN 1200

Lab Reports

Date: , THRN 1008

See the Lab Schedule (Section 5.2) for lab schedule and report due dates.

Project

Date: , THRN 1008

See Lab Schedule (Section 5.2) for Project schedule and report deadlines.

Midterm

Date: October 24, 11:30 AM to 12:50 PM (in class), THRN 1200

Each student is allowed one ***single-sided*** 8.5" x 11" note sheet for the exam. Each note sheet must be prepared by you (typed or handwritten) and be your own original work (i.e. not a copy).

Final Exam

Date: December 14, 11:30 AM to 1:30 PM, Room TBD

Each student is allowed one ***double-sided*** 8.5" x 11" note sheet for the exam. Each note sheet must be prepared by you (typed or handwritten) and be your own original work (i.e. not a copy).

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7 Course Statements

7.1 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. 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 at the start 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: Students must achieve at least 50% of the marks assigned to the midterm and final exams in order for the labs and quizzes to be counted in the final grade. If you do not achieve at least 50% of the marks assigned to the midterm and final exams, the weighting of the lab reports and quizzes in your final grade will be zero. An overall final grade of 50% is required to pass the course.

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

Lab Work: You must attend and complete all labs. Doors to the lab will be closed 15 minutes after the scheduled lab time. **Students arriving after the lab doors are closed are considered absent.** If you miss a lab due to grounds for granting academic consideration or religious accommodation, arrangements must be made with the teaching assistant to complete a makeup lab **prior** to your scheduled lab. Unless academic consideration is granted, failure to complete a lab will result in a mark of zero for that lab report.

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 Monday, September 11, 2017**. Be sure to choose your lab partners wisely! The sign-up sheets for lab groups will be available in the Materials Lab in THRN 1008 during the introductory lab session. **You will not be allowed to conduct the project or labs unless you attend the safety session and sign a form indicating that you have done so.**

Each group will be responsible for conducting 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. Lab reports will be marked and the marks posted on Courselink. **Note that up to 20% of the lab mark may be deducted for poor lab report format, poor graph or table format, or poor English (spelling, grammar, etc.).** 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.

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 regulations and procedures for Academic Consideration are detailed in the Undergraduate Calendar.

9.3 Drop Date

Courses that are one semester long must be dropped by the end of the fortieth class day; two-

semester courses must be dropped by the last day of the add period in the second semester. The regulations and procedures for Dropping Courses are available in the Undergraduate Calendar.

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.

More information: www.uoguelph.ca/sas

9.6 Academic Misconduct

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 discourages misconduct. 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.

The Academic Misconduct Policy is detailed in the Undergraduate Calendar.

9.7 Recording of Materials

Presentations which are made in relation to course work—including lectures—cannot be

recorded or copied without the permission of the presenter, whether the instructor, a classmate 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 which apply to undergraduate, graduate and diploma programs.
