

# ENGG\*2120 Materials Science

Winter 2015



School of Engineering

(Revision 0: January 5, 2015)

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## 1 INSTRUCTIONAL SUPPORT

### 1.1 Instructor

Instructor: Ryan Clemmer, Ph.D., P.Eng.  
Office: THRN 1337, ext. 52132  
Email: rclemmer@uoguelph.ca  
Office hours: Mondays 10:00 – 11:00 AM or drop-in

### 1.2 Lab Technician

Technician: Barry Verspagen  
Office: THRN 1138, ext. 58821  
Email: baverspa@uoguelph.ca

### 1.3 Teaching Assistants

<b>GTA</b>	<b>Email</b>	<b>Office Hours</b>
Alex Matysiak	amatysia@uoguelph.ca	By appointment
David Wood	woodd@uoguelph.ca	By appointment
Richard Chen	hchen01@uoguelph.ca	By appointment
Michael Snowdon	snowdonm@uoguelph.ca	By appointment
Yunzhi Li	yunzhi@uoguelph.ca	By appointment

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## 2 LEARNING RESOURCES

### 2.1 Course Website

Course material, news, announcements, and grades will be regularly posted to the ENGG\*2120 Courselink site. You are responsible for checking the site regularly.

### 2.2 Required Resources

1. D.R. Askeland, P.P. Fulay, W.J. Wright, *The Science and Engineering of Materials*, 6<sup>th</sup> Edition, SI, Cengage Learning, 2011.
2. I-clickers for quizzes

### 2.3 Recommended Resources

1. W.D. Callister and D.G. Rethwisch, *Materials Science and Engineering: An Introduction*, 8<sup>th</sup> Edition, John Wiley & Sons, Inc., 2010.

### 2.4 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.

### 2.5 Communication & Email Policy:

Please use lectures and lab help sessions as your main opportunity to ask questions about the course. Major announcements will be posted to the course website. **It is your responsibility to check the course website regularly.** As per university regulations, all students are required to check their <mail.uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its students.

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## 3 ASSESSMENT

### 3.1 Dates and Distribution

Assessment	Marking Scheme A	Marking Scheme B
Quizzes	10%	0%
Project	5%	5%
Labs	20%	20%
Midterm	25%	30%
Final Exam	40%	45%
Total	100%	100%

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

**Quizzes:** (best 5 of 7)

Jan 16, in class  
Jan 26, in class  
Feb 11, in class  
Feb 25, in class  
Mar 9, in class  
Mar 20, in class  
Apr 1, in class

**Labs:** See section 5.3 below for due dates

**Project:** Report due: Feb 2 – Feb 6 (See section 5.3)

**Midterm:** Part 1: Fri, Feb 27, 3:30 PM – 4:20 PM, ALEX 100 – in class  
Part 2: Mon, Mar 2, 3:30 PM – 4:20 PM, ALEX 100 – in class

Each student is allowed only one **single-sided** 8.5” x 11” note sheet for both parts of the midterm exam. That is, the same notesheet must be used for both parts of the midterm. Each note sheet must be prepared by you and be your own original work (i.e. not a copy).

**Final Exam:** Wed Apr 8, 11:30 AM – 1:30 PM, Room TBA on Webadvisor

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

### 3.2 Course Grading Policies

**Quizzes:** There will be several i>clicker quizzes during the lectures throughout the semester as scheduled. Students are expected to be present and use their own i>clicker during these quizzes. The quizzes are intended to help you better understand the course content and account for 10% of the course marks. You will receive 1 mark for each question answered and an additional 2 marks if the answer is correct. Prior to the first quiz, you must register your i>clicker serial number by clicking on the “*Student i>clicker Registration*” link on the right side of the webpage:  
<http://www.tss.uoguelph.ca/lci/clickers/index.cfm>

**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 locked 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 Friday, January 16<sup>th</sup>**. 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. Lab reports will be handed back to the group during the lab session after all reports for that specific lab have been handed in. 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.

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## 4 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

### 4.1 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.

*Prerequisite(s):* CHEM\*1040, PHYS\*1130

### 4.2 Course Aims

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.

### 4.3 Learning Objectives

At the successful completion of this course, the student will have demonstrated the ability to:

1. Describe the general properties of key engineering materials: metals, ceramics, polymers, and composites through a material identification project and exam questions
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 and exams
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 discussion
5. Read and interpret phase diagrams through practise 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

#### 4.4 Graduate Attributes

Successfully completing this course will contribute to the following CEAB Graduate Attributes:

<b>Graduate Attribute</b>	<b>Learning Objectives</b>	<b>Assessment</b>
1. Knowledge Base for Engineering	1, 2, 3, 5, 7	Quizzes, Exams
2. Problem Analysis	-	-
3. Investigation	4, 6, 8	Labs, Project
4. Design	-	-
5. Use of Engineering Tools	4, 6	Labs, Project
6. Individual and Teamwork	-	-
7. Communication	6, 8	Labs, Project
8. Professionalism	-	-
9. Impact of Engineering on Society and the Environment	-	-
10. Ethics and Equity	-	-
11. Environment, Society, Business, & Project Management	-	-
12. Life-Long Learning	-	-

#### 4.5 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.

#### 4.6 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.

#### 4.7 Relationships with other Courses & Labs

##### Previous Courses:

**CHEM\*1040:** Topics include chemical bonding, simple reactions and stoichiometry, chemical equilibria and solution equilibria.

**PHYS\*1130:** Topics include waves, acoustics, optics, electric field and potential, DC circuits, power transmission, nuclear processes, and radioactivity.

**Follow-on Courses:** **ENGG\*3170:** Biomaterials, **ENGG\*3670:** Soil Mechanics, **ENGG\*3280:** Machine Design, **ENGG\*3070:** Integrated Manufacturing Systems

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## 5 TEACHING AND LEARNING ACTIVITIES

### 5.1 Timetable

#### Lectures:

Monday	3:30PM – 4:20PM	ALEX 100
Wednesday	3:30PM – 4:20PM	ALEX 100
Monday	3:30PM – 4:20PM	ALEX 100

#### Laboratory:

Monday	Sec 07	8:30 AM - 10:20AM	THRN 1008
Monday	Sec 06	11:30 AM - 1:20 PM	THRN 1008
Tuesday	Sec 04	8:30 AM - 10:20AM	THRN 1008
Tuesday	Sec 03	3:30 PM - 5:20 PM	THRN 1008
Wednesday	Sec 08	8:30 AM - 10:20AM	THRN 1008
Thursday	Sec 05	8:30 AM - 10:20AM	THRN 1008
Thursday	Sec 02	3:30 PM - 5:20 PM	THRN 1008
Friday	Sec 01	11:30 AM - 1:20 PM	THRN 1008

### 5.2 Lecture Schedule

Lectures	Lecture Topics	References	Learning Objectives
Week 1	Introduction	Chapter 1	1
Week 2	Mechanical Properties	Chapter 6	1, 2
Week 3	Failure Mechanisms	Chapter 7	1, 2, 3
Week 3	Atomic Structure	Chapter 2	2
Week 4	Ferrous & Nonferrous metals	Chapter 13, 14	1
Week 5	Ceramic Materials	Chapter 15	1
Week 5	Polymer Materials	Chapter 16	1
Week 6	Composite Materials	Chapter 17	1
Week 6	Atomic Arrangement	Chapter 3	2
Week 7	Imperfections in Atomic Arrangement	Chapter 4	2
Week 8	Solid Solutions	Chapter 10	5
Week 8	Dispersion Strengthening – Phase Diagrams	Chapter 11	3
Week 9	Dispersion Strengthening – Phase Transformations	Chapter 12	3
Week 10 & 11	Heat Treatment of Steel	Chapter 13	3
Week 12	Strain Hardening	Chapter 8	3

### 5.3 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 for marking in the assignment drop-off cabinet located in the engineering alley by the Machine Shop (THRN 1015) by 4:00 PM **two weeks** (except the tensile lab as indicated) after the laboratory is performed and electronically in the dropbox on courselink. 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.

<b>Lab</b>	<b>Groups</b> (for all sections)	<b>Lab Performed</b>	<b>Report Due Date</b>
Lab Safety and Project Introduction	1-4	Jan 12 - 16	
	5-8	Jan 12 - 16	
Additional Project Testing	1-4	Jan 19 - 23	Feb 2 – Feb 6
	5-8	Jan 19 - 23	Feb 2 – Feb 6
Compressive Testing of Materials	1-4	Jan 26 - 30	Feb 9 – Feb 13
	5-8	Jan 26 - 30	Feb 9 – Feb 13
Tensile Testing of Materials	1-4	Feb 2 – Feb 6	Feb 23 – Feb 27
	5-8	Feb 9 – Feb 13	Mar 2 – Mar 6
Midterm Review	ALL	Feb 23 – Feb 27	Midterm: Feb 27, Mar 2
Impact Testing of Metals	1-4	Mar 2 – Mar 6	Mar 16 – Mar 20
	5-8	Mar 2 – Mar 6	Mar 16 – Mar 20
Heat Treatment of Metals	1-4	Mar 9 – Mar 13	Mar 23 – Mar 27
	5-8	Mar 16 – Mar 20	Mar 30 – Apr 3

### 5.4 Other Important Dates

- Monday, January 5, 2015: First day of class
- Monday, February 16 – Friday, February 20, 2015: Winter Break
- Friday, March 6, 2015: drop date – 40th class
- Thursday, April 2, 2015: last day of classes



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## 6 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.

### 6.1 Materials Lab Safety

This section outlines some of the safety related procedures and information for use in the Materials Science Lab in THRN 1008. Safety in the laboratory is critical. **You will not be allowed to do the project or the labs unless you attend the safety session and sign a form indicating that you have done so.** If you have any concerns or comments related to safety in this laboratory you can reach Barry Verspagen, at ext. 58821, in THRN 1138.

1. Be prepared. You should download and print a copy of the ENGG\*2120 Lab Manual from Courselink. Be sure to carefully read the specific manual section before you go to perform each of the laboratory exercises.
2. You must do as instructed by the laboratory demonstrator. If you are not sure about something ask the demonstrator. Inform the demonstrators if you become aware of a potential hazard.
3. Food and beverages cannot be stored or consumed in this laboratory
4. Safety glasses are mandatory for all experiments. You will not be allowed to perform an experiment without them.
5. Proper footwear is mandatory for all the experiments. This means no open toed shoes or sandals.
6. The fire extinguisher, first aid kit, and phone are located at the front of the lab (THRN 1008). Dial ext. 52000 in case of emergencies.
7. All accidents should be reported to the demonstrator.

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## 7 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.

### 7.1 Resources

The Academic Misconduct Policy is detailed in the Undergraduate Calendar:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

A tutorial on Academic Misconduct produced by the Learning Commons can be found at:

<http://www.academicintegrity.uoguelph.ca/>

Please also review the section on Academic Misconduct in your [Engineering Program Guide](#).

The School of Engineering has adopted a Code of Ethics that can be found at:

<http://www.uoguelph.ca/engineering/undergrad-counselling-ethics>

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## 8 ACCESSIBILITY

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability for a short-term disability should contact the Centre for Students with Disabilities as soon as possible

For more information, contact CSD at [519-824-4120](tel:519-824-4120) ext. 56208 or email [csd@uoguelph.ca](mailto:csd@uoguelph.ca) or see the website: <http://www.uoguelph.ca/csd/>

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## 9 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, classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

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## 10 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:

<http://www.uoguelph.ca/registrar/calendars/index.cfm?index>