

ENGG*2120 Materials Science

Fall 2015



School of Engineering

(Revision 0: September 10, 2015)

1 INSTRUCTIONAL SUPPORT

1.1 Instructor

Instructor: Ryan Clemmer, Ph.D., P.Eng.
Office: THRN 1337, ext. 52132
Email: rclemmer@uoguelph.ca
Office hours: Thursdays 2:00 – 3:00 PM or drop-in

1.2 Lab Technician

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

1.3 Teaching Assistants

| GTA | Email | Office Hours |
|--------------------|----------------------|---------------------|
| Richard Chen | hchen01@uoguelph.ca | By appointment |
| Abdelkrem Eltaggaz | aeltagga@uoguelph.ca | By appointment |
| Eugene Enriquez | enriquee@uoguelph.ca | By appointment |
| James Harnum | jharnum@uoguelph.ca | By appointment |
| Kazi Tahsin | ktahsin@uoguelph.ca | By appointment |

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, and W.J. Wright, *The Science and Engineering of Materials*, 7th Edition, SI, Cengage Learning, 2015.
2. I-clickers for quizzes

2.3 Recommended Resources

1. W.D. Callister and D.G. Rethwisch, *Materials Science and Engineering: An Introduction*, 8th 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.

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)

Sep 22, in class
Oct 6, in class
Oct 22, in class
Nov 3, in class
Nov 12, in class
Nov 24, in class
Dec 3, in class

Labs: See section 5.3 below for due dates

Project: Report due: Oct 6– Oct 9 (See section 5.3)

Midterm: Tues Oct 27, 4:00 PM – 5:20 PM, ROZH 103 & 106 – in class

Each student is allowed one **single-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).

Final Exam: Mon Dec 7, 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. 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/lc/i/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 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 21st**. 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.

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, 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 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:

| Graduate Attribute | Learning Objectives | Assessment |
|--|----------------------------|-------------------|
| 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

5 TEACHING AND LEARNING ACTIVITIES

5.1 Timetable

Lectures:

| | | |
|----------|-----------------|----------------|
| Tuesday | 4:00PM – 5:20PM | ROZH 103 & 106 |
| Thursday | 4:00PM – 5:20PM | ROZH 103 & 106 |

Laboratory:

| | | | |
|-----------|--------|-------------------|-----------|
| Tuesday | Sec 01 | 11:30 AM - 1:20PM | THRN 1008 |
| Tuesday | Sec 02 | 1:30 PM - 3:20 PM | THRN 1008 |
| Wednesday | Sec 03 | 11:30 AM - 1:20PM | THRN 1008 |
| Wednesday | Sec 04 | 1:30 PM - 3:20 PM | THRN 1008 |
| Wednesday | Sec 05 | 3:30 PM - 5:20 PM | THRN 1008 |
| Thursday | Sec 06 | 11:30 AM - 1:20PM | THRN 1008 |
| Thursday | Sec 07 | 1:30 PM - 3:20 PM | THRN 1008 |
| Friday | Sec 08 | 12:30 PM - 2:20PM | THRN 1008 |
| Friday | Sec 09 | 2:30 PM - 4:20 PM | THRN 1008 |

5.2 Lecture Schedule

| Lectures | Lecture Topics | References | Learning Objectives |
|----------|--|----------------|---------------------|
| 1 | Introduction | Chapter 1 | 1 |
| 2, 3 | Mechanical Properties | Chapter 6 | 1, 2 |
| 4, 5 | Failure Mechanisms | Chapter 7 | 1, 2, 3 |
| 6 | Atomic Structure | Chapter 2 | 2 |
| 7 | Ferrous & Nonferrous metals | Chapter 13, 14 | 1 |
| 8 | Semiconductors & Ceramic Materials | Chapter 15 | 1 |
| 9, 10 | Polymer Materials | Chapter 16 | 1 |
| 11 | Composite Materials | Chapter 17 | 1 |
| 12, 13 | Atomic Arrangement | Chapter 3 | 2 |
| 14, 15 | Imperfections in Atomic Arrangement | Chapter 4 | 2 |
| 16, 17 | Solid Solutions | Chapter 10 | 5 |
| 18, 19 | Dispersion Strengthening – Phase Diagrams | Chapter 11 | 3 |
| 20, 21 | Dispersion Strengthening – Phase Transformations | Chapter 12 | 3 |
| 22 | Heat Treatment of Steel | Chapter 13 | 3 |
| 23, 24 | 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 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 | 1-3 | Sep 15 – Sep 18 | |
| | 4-6 | Sep 15 – Sep 18 | |
| Project Testing | 1-3 | Sep 22 – Sep 25 | Oct 6 – Oct 9 |
| | 4-6 | Sep 22 – Sep 25 | Oct 6 – Oct 9 |
| Compressive Testing of Materials | 1-3 | Sep 29 – Oct 2 | Oct 20 – Oct 23 |
| | 4-6 | Sep 29 – Oct 2 | Oct 20 – Oct 23 |
| Tensile Testing of Materials | 1-3 | Oct 20 – Oct 23 | Nov 3 – Nov 6 |
| | 4-6 | Oct 27 – Oct 30 | Nov 10 – Nov 13 |
| Midterm Review | 1-3 | Oct 14 – Oct 16 | Midterm Oct 27 |
| | 4-6 | Oct 14 – Oct 16 | Midterm Oct 27 |
| Impact Testing of Metals | 1-3 | Nov 3 – Nov 6 | Nov 17 – Nov 20 |
| | 4-6 | Nov 3 – Nov 6 | Nov 17 – Nov 20 |
| Heat Treatment of Metals | 1-3 | Nov 10 – Nov 13 | Nov 24 – Nov 27 |
| | 4-6 | Nov 17 – Nov 20 | Dec 1 – Dec 4 |

5.4 Other Important Dates

- Thursday, September 10, 2015: First day of class
- Monday, October 12, 2015 Holiday: No classes scheduled
- Tuesday, October 13, 2015: Fall Study Break Day – No classes scheduled
- Friday, November 6, 2015: 40th class day, last day to drop
- Friday, December 4, 2015: Last day of class

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.

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>

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 or see the website: <http://www.uoguelph.ca/csd/>

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.

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>