ENGR 361
ENGINEERING MATERIALS
Spring 2014

COURSE DESCRIPTION:
This course introduces the theory and application of engineering materials, covering both traditional structural materials and emerging materials technologies. The physical and mechanical properties, uses and limitations of metals, ceramics, polymers, and composite materials are explored. Particular emphasis is placed on how material performance and properties are intimately linked to material structure and processing. Both materials selection and design of new materials is explored and executed. Developments in advanced materials (semiconductor, nano-, bio-, smart- materials) will be highlighted throughout to ensure an understanding of the expanding materials landscape.

LECTURE TIMES AND LOCATION:
ENGR 361-02: MWF 1:35-2:40 PM in OSS 313

ASSOCIATED LAB:
ENGR 361-52 and -54 are the laboratory parts of this course.
You are required to take one of them.
ENGR 361-52: Thurs 1:30-4:00PM; OSS 325
ENGR 361-54: Mon 2:55-5:25PM; OSS 325

COURSE INSTRUCTOR:
Dr. Brittany Nelson-Cheeseman
Office: OSS 319
Office Phone: 651-962-5773
Email: bbnelsonchee@stthomas.edu
Office Hours: Email with request for meeting.

REQUIRED TEXT:
The textbook plays a central role in the course. Be aware that it is the student's responsibility to read the chapters listed in the schedule on the last page. Understanding this material will be essential to doing well in the course.

- W.D. Callister, and D.G. Rethwisch. *Fundamentals of Materials Science and Engineering: An Integrated Approach.* 4th Ed, John Wiley & Sons

REQUIRED EQUIPMENT:
Each student is required to bring a Turning Point Clicker to every lecture period to help provide engagement with the material and feedback on their understanding of the material.

REFERENCE TEXT:
- M. Ashby, *Materials Selection in Mechanical Design*
- ASM Engineered Materials Handbook: Vol.2, *Engineering Plastics*
- ASM Engineered Materials Handbook: Vol.4, *Ceramics and Glasses*

IDEA LEARNING OUTCOMES:
Through this course, students will:
- Gain factual knowledge on how to classify:
    - Types of materials
    - Structures of materials, on multiple length scales
    - Materials properties; materials processing techniques
    - Common applications of materials
- Analyze materials using the fundamental principle of materials engineering:
    - The intimate connection between processing, structure, properties, and performance.
- Apply course material to improve thinking, problem solving, and decisions:
    - By properly selecting existing materials for targeted applications
    - By proposing plausible designs of new materials for targeted applications.
- Practice finding and using resources for answering questions and solving problems thru:
    - A materials research project (the Materials Wikipedia Project)
    - A materials design project (the Material by Design Project)

ABET LEARNING OUTCOMES:
- Relate theory to processing and performance of materials, as demonstrated by successful completion of homework and exams (a, h)
- Communicate effectively in the terminology of materials science, as demonstrated by class response, writing assignments, and discussion of experimental findings (a, g)
- Measure and apply materials properties to engineering problems, demonstrated by successful completion of Materials by Design project (b, d, e, g)
- Design a new material for an existing application with the Materials by Design project. Relate selection and processing of materials to economy, performance and sustainability. (a, b, c, d, e, g, h, k)

GRADING:
Lecture - 600 pts [75%]; Lab - 200 pts [25%] (see separate Lab Syllabus for details)
Note: a passing grade is required in both lab and lecture.

<u>Lecture Grade Breakdown (600 pts):</u>
- **Pre-Lecture Quizzes** – 80 pts (10%)
- **Homeworks (8)** - 15 pts each = 120 pts (15%)
- **Exams (4)** - 200 pts total (25%)
- **Materials Wikipedia Project** = 100 pts (12.5%)
    - Draft Wikipedia Page - 20 pts
    - Peer Reviews of Drafts – 5 pts for each review completed by Reviewer (x5)
        (emphasis on quality of review)
    - Final Wikipedia Page - 30 pts
    - Peer Reviews of Final Wikipedia Pages - 5 pts for each review of Author (x5)
        (emphasis on quality of final product)
- **Materials by Design Project** = 100 pts (12.5%)
    - Updates - 5 pts (4), 10 pts (2) = 40 pts
    - Draft Proposal Outline (1) = 15 pts
    - Final Proposal (1) = 45 pts

Pre-Lecture Quizzes

Pre-lecture quizzes will consist of questions based off the assigned reading, and is meant to help students highlight main topics within the reading before coming to lecture. Quizzes are to be submitted online via Bb and are *to be completed by 12noon before lecture*. Late quizzes will not be accepted. These quizzes are intended to:

1. Help prepare students for in-depth and active engagement with the material during class time.
2. Provide instructor with feedback on sections of the material that the students are finding unclear or difficult. Class time will be used to address and clarify these issues for the students.

In-Class Clickers

Students will be required to have a Turning Point Technologies clicker for every class period. These allow for in-class engagement with the material and feedback to both the student and the instructor on whether the student is mastering the concepts.

Homework

Homework will consist of problems that reinforce content and skills (both quantitative and qualitative.) Homework is to be turned in at the *beginning* of lecture. Late homework will be accepted up to 24 hrs late with a 20% penalty unless alternate arrangements are made earlier. No late homework will be allowed after 24 hours. In order to be accepted, homework must be neat and list problems in the order they appear in the assignment.

Exams

Questions will be both qualitative and quantitative and cover subjects presented in both the lecture and lab portions of the course. Exams will be cumulative. Retention of the major concepts of the whole course will be expected.

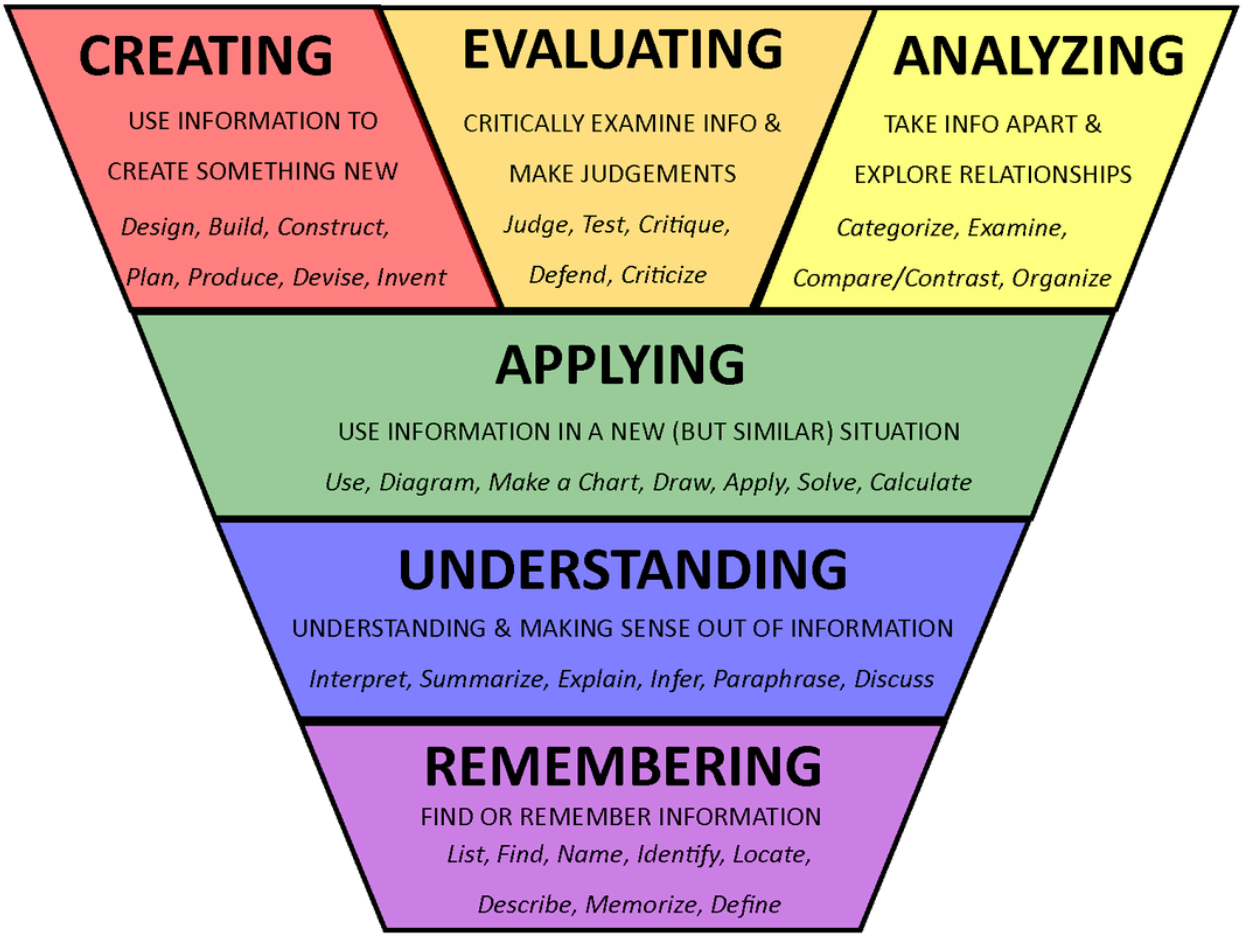
Materials Wikipedia Project

This project will be a collective class effort to compile a Wikipedia of interesting materials. *The objectives of the project are to expand our knowledge and exposure to a broad cross-section of materials, to highlight the applications in which certain materials are commonly selected for use, and to help the student learn how to execute good technical writing.* Each page will give a short overview of the material by describing its history, structure, properties, processing, and performance/applications. Each student will contribute 1 wiki pg of an interesting material of their choice. Duplicate/overlapping materials will not be allowed; preference will be given to whoever posts their choice first on Blackboard. Students will review a total of 10 fellow students' pages to learn about different materials and reinforce good technical writing skills.

Material by Design Project

The objectives of this project are to help the student understand and execute the engineering design process of a new material for a targeted application, as well as help the student practice sound technical writing. It will be a semester-long project that we tackle in stages, and that culminates in a final proposal paper at the end of the semester. Each student will be tasked with identifying an application of interest in which they desire enhanced materials performance. Applying the content and strategies learned in this course, the student will detail their understanding of the current material(s) used and propose the design of a plausible new material that would demonstrate the desired enhanced performance.

BLOOM's TAXONOMY OF LEARNING:



From: http://www.meandmylaptop.com/2/post/2012/07/simplified-blooms-taxonomy-visual.html

ATTENDANCE:
Students are expected to attend all lecture sessions. The student is expected to review the assigned reading material *prior to* class and actively participate in class. All absences require that the instructor be informed in advance if at all possible. Circumstances that prevent attendance will be honored three times. Contact the instructor when a special situation arises. Periodically, class will be poled for attendance and use of clickers.

ACADEMIC INTEGRITY:
All students are expected to understand and follow the University of St. Thomas policies on Academic Integrity. These are described at:
http://www.stthomas.edu/policies/undergraduate/disciplinaryrights/academic/
Plagiarism, especially in regards to the Materials Wikipedia project or the Material by Design Project, will not be tolerated. All sources must be properly cited.

BLACKBOARD WEBSITE:
http://blackboard.stthomas.edu/ (access using St. Thomas login ID and password)

Blackboard Announcements:
It is each student's responsibility to stay aware of announcements and assignments on the ENGR 361 Blackboard website. When significant or timely information is posted, the students will be notified via their official @stthomas.edu email address. In order to be sure they are notified of the new information, it is the student's responsibility to: (1) check his or her email regularly, and (2) maintain their accounts below full capacity so that notification emails are not rejected/lost.

Blackboard Assignments:
Assignments for the Materials Wikipedia and Material by Design Projects will be maintained online within the Blackboard webpage. It is the responsibility of the student to check to be sure they are proficient with the online tools used (wiki pages, blogs) well before the deadlines for such assignments.

LIBRARY RESOURCES:
The student's use of the University of St. Thomas Library system, particularly the electronic resources, will be imperative for completion of the Materials Wikipedia Project and the Materials by Design Project. The student should familiarize themselves with the online Engineering Resources guide: http://libguides.stthomas.edu/content.php?pid=112493&hs=a. For helpful suggestions on how to begin doing research for these projects, the student may consult: http://www.stthomas.edu/libraries/research/tutorials/default.html. In order to familiarize and reinforce the student with current standards of writing practice in science and engineering, both projects will require complete and accurate citation of work acquired through journal articles, books, handbooks, or otherwise published reference work. *Note that excessive citation of Wikipedia.com webpages will be viewed as unprofessional.*

DISABILITY ACCOMODATION:
I want to ensure that the classroom environment is conducive to your learning and ask that you discuss with me any concerns that are interfering with your learning as they arise. Classroom accommodations will be provided for students with documented disabilities. Students must contact the Disability Resources Office about accommodations for this course as early in the semester as possible. Appointments can be made by calling 651-962-6315 or 800-328-6819, extension 6315, or in person in Rm 110 Murray Herrick Center on the St. Paul campus. Further information is available at: www.stthomas.edu/enhancementprog/.

INSTRUCTOR BIO:
Dr. Brittany Nelson-Cheeseman received her MS and PhD in Materials Science and Engineering (MSE) at the University of California-Berkeley, and her BS in MSE at the University of Wisconsin-Madison. She most recently was a postdoctoral researcher at Argonne National Laboratory (under the US Department of Energy) located outside Chicago, IL, where she worked on discovering and investigating novel nanoscale materials for energy applications.

IMPORTANT DATES:
(Check Blackboard website for updates as dates are subject to change.)

Feb 5	Materials by Design 1: *Factors of Design* (5 pts)
Feb 10	Materials Wikipedia: *Materials Choices*
Feb 14	Homework 1 (15 pts)
Feb 17	Draft of Materials Wikipedia Page (20 pts)
Feb 21	Homework 2 (15 pts)
Feb 24	Materials Wikipedia Page Reviews (5 pts (x5))
Feb 26	Homework 3 (15 pts)
Mar 3	Exam I (55 pts)
Mar 7	Final Materials Wikipedia Page (30 pts)
Mar 10	Final Materials Wikipedia Page Reviews (5 pts (x5))
Mar 17	Materials by Design 2: *Chosen Application, Performance Criteria* (5 pts)
Mar 17	Homework 4 (15 pts)
Mar 24-28	No Lecture/Lab (Spring Break)
Mar 31	Materials by Design 3: *Desired Properties, Current Materials* (5 pts)
Apr 4	Homework 5 (15 pts)
Apr 7	Exam II (45 pts)
Apr 11	Materials by Design 4: *Current Materials Design*, *Structure Target(s)* (10 pts)
Apr 16	Homework 6 (15 pts)
Apr 28	Materials by Design 5: *Biomimicry Inspiration* (5 pts)
Apr 30	Homework 7 (15 pts)
May 2	Exam III (50 pts)
May 7	Material by Design 6&7: *Processing Strategies & Unconventional. Matls* (10 pts)
May 12	Draft Materials by Design Proposal Outline (15 pts)
May 16	Homework 8 (15 pts)
May 21	Final Exam (10:30-12:30am) (50 pts)
May 23	Final Materials by Design Proposal (45 pts)

ENGR 361 Course Outline, Spring 2014, Callister 4th Ed.		
Week	**Lecture topics shown in Black.** *Lab activities shown in Red.*	**TEXT SECTIONS**
-1- *Feb 3*	Intro to MSE; Atomic Structure & Bonding; Crystallinity *LAB: EduPack Exercises (5%); Polymer Flow Chart, FTIR (5%);*	Ch. 1, 2, 3.1-11
-2- *Feb 10*	Crystal Space; Unit Cells; and Polymer Structure *LAB: Online Exercises; Unit Cell Kit; Balls & Sticks; Polymer Kit (5%)*	Ch. 3.12-21 Ch. 4
-3- *Feb 17*	Imperfections in Solids; Diffusion; Phase Diagrams (non-Fe) *LAB: Online Exercises; Unit Cell Kit; Balls & Sticks (5%); Rev Engr Overview*	Ch. 5 Ch. 6 Ch. 10.1-16
-4- *Feb 24*	Phase Transformations (non-Fe); Exam Review (W); Exam Review (F) *LAB: Breakdown Rev. Engr. Items; Work on Rev. Engr. Project*	Ch. 11.1-4 Ch. 11.13-17
-5- *Mar 3*	**Exam I (55pts) (M);** Phase Diagrams (Fe-C); Phase Transformations (Fe-C); *NO LAB*	Ch. 10.19-21 Ch. 11.5-12
-6- *Mar 10*	Mechanical Properties-Elastic Deformation; Metals: Mech. Properties, Deformation and Strengthening Mechanisms *LAB: Metals Tensile Test; Hardness Test (15%)*	Ch. 7.1-5, 6-9 Ch. 8.1-14 Ch. 9.1-3
-7- *Mar 17*	Ceramics & Polymers: Mech. Properties, Deformation and Strengthening Mechanisms; Failure; *LAB: Polymer/Composite Tensile Test (15%)*	Ch. 7.10-18 Ch. 8.15-19 Ch. 9.4-7, Skim 8-19
-8- *Mar 24*	*No Class. Spring Break.* *NO LAB.*	n/a
-9- *Mar 31*	Composites; Exam Review (W); **Exam II (45 pts) (F)** *LAB: Testing of Rev. Engr. Project Materials & EDS Sample Selection.*	Ch. 15
-10- *Apr 7*	Electrical Properties; Thermal Properties *LAB: Piezoelectric Materials (5%)*	Ch. 12.1-8, 10-13, Ch. 12.16-19, 24-25 Ch. 17.1-5
-11- *Apr 14*	Optical Properties; Magnetic Properties; No Classes (F) *LAB: Testing of Rev. Engr. Project Materials & EDS Sample Selection.*	Ch. 19.1-12 Ch. 18.1, 3-10, 12
-12- *Apr 21*	No Classes (M); Corrosion & Degradation of Materials *NO LAB.*	Ch. 16.1-2 Ch. 16. 5-9, 11
-13- *Apr 28*	Exam Review (M,W); **Exam III (50 pts) (F)** *LAB: Rev. Engr. Final Testing and Presentation Synthesis*	
-14- *May 5*	Types & Applications; Synthesis, Fabrication, & Processing of Materials *LAB: UMN Electron Microscopy Demo & Cleanroom Tour (5%)*	Ch. 13 Ch. 14
-15- *May 12*	Materials Selection, Exam Review (W, F) *LAB: Rev Engr Final Presentation (Presentation - 30%; Report – 10%)*	
-16- *Mar 19*	**Final Exam (50 pts)** Wed, May 21 – 10:30am-12:30pm	