## Standards in the Classroom Course Materials

Wherever your students are headed, help them get there by including technical standards in their education. For more information, click on any of the course material below:

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<th>University of Mississippi</th>
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<td>Civil and Environmental Engineering</td>
<td>Food Science Department</td>
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<td><em>Experimental Characterization of Polymeric Composites</em></td>
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<th>Amarillo College</th>
<th>Oklahoma State University</th>
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<td>Manufacturing Technologies</td>
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The ASTM International Classroom Course Materials page is a free online tool for professors to share information about standards education that can be freely used in curriculum.

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Users should independently investigate the validity of the material listed.

If you would like to create a listing or have any questions or comments, please contact Jim Olshefsky at jolshefs@astm.org
Amarillo College

Department  Nondestructive Testing and Evaluation
Title  Radiographic Testing - Level 2
Hours  (3 sem hrs; 2 lec, 2 lab)

Description  An intermediate level course meeting the requirements of the American
Society for Nondestructive Testing training outline for Level 2.
Preparation for successful employment and certification in the
Radiographic Testing method. A theoretical study and practical
application with emphasis on industry standards, equipment calibration,
process capability and limitations, indication interpretation and
evaluation, and data reporting.

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Kim T. Hays Ed.D., Amarillo College, Amarillo, TX
Course Syllabus

Radiographic Testing - Level II

1. Understand darkroom facilities, techniques and processing.
2. Perform film loading and film processing.
3. Demonstrate radiography using correct film handling and exposure techniques.
4. Understand radiographic viewing and application.
5. Explain indications, discontinuities, and defects.
6. Evaluate radiographs of castings and weldments.
7. Demonstrate the use of ASTM standards, codes and procedures in submission of reports.

Students must meet the requirements of ASNT-CP189 as referenced in ASNT SNT-TC-1A. Students cannot pass this class unless these requirements have been met.

Course Evaluations:

Students should complete all performance tasks on time at REQUIRED MASTERY LEVEL. Tasks, projects, and various assignments will be scored based on time; accuracy; neatness; completeness; procedure; skill; detail; motivation and attitude; safety practices; clean up; care of manuals, logbooks, and references; and other grading criteria. No task shall be rated until assignment is complete. Complete shall include condition and cleanliness of equipment; clean up of work areas; tool condition and return; all projects, supplies and materials being stored properly. Failure to bring books, notes, notebook, and equipment for a given class may result in a failing grade for that class period.

*The final composite grade must be 80 percent per ASNT SNT-TC-1A to receive a passing grade.

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Students are responsible for getting notes from other students when absent. Lab activities will continue on schedule. Individuals will not receive credit for making up activities and there will not be special lab sessions. Some work can be caught up during regular lab times. Missing lab activities may prevent individuals from performing advanced lab exercises for safety and expense reasons. **Minimum hour requirement per American Society for Nondestructive Testing (ASNT) must be met to pass the class.**

**Required_Exams**

Each unit will require a written examination. Each session is subject to testing on previous material.

A comprehensive written final exam will be given along with the last unit performance exam.

**Final_Exams**

For Level I and II personnel, a composite grade should be determined by simple averaging of the results of the general, specific, and practical examinations. Examinations administered for qualification should result in a passing composite grade of at least 80 percent, with no individual examination having a passing grade less than 70 percent. ~ASNT SNT-TC-1A:8.0

Student outcomes must satisfy the recommended practices of ASNT-CP105 as referenced in the ASNT SNT-TC-1A.

**Objectives**

Upon successful completion students shall be able to demonstrate knowledge of Radiographic Testing II: 1) theory and concepts, 2) standards, 3) equipment calibration and calibration standards, 4) testing process and limitations, 5) indication interpretation and evaluation, and 6) data reporting.

Upon successful completion students shall be able to demonstrate skills in Radiographic Testing II: 1) standards interpretation, 2) equipment calibration, 3) testing, 4) indication interpretation and evaluation, 5) data recording and reporting.

**Behavior**

To better focus on the learning environment, communication during class time should be directed toward class activities and outside communication should be limited to emergencies only. Any means of electronic communication will only be tolerated in emergency
situations. Any abuse of this expected behavior can be subject to removal of the student from class.

**Notebook & Class Equipment**

Students are required to take notes during lectures, and to turn in a notebook for grading prior to the final exam. Articles, accumulated information, and useful reference material that pertain to relative course topics will be counted towards the notebook grade. Notebook should contain handouts, formula sheets, test, assignments, and task list. All items will be graded from the notebook. Student shall furnish a scientific calculator and personal protective equipment to include safety glasses. Student shall have their own personal hand tools similar to those on the department service tool list. Student shall furnish necessary computer media for information transfer. Student shall furnish required text and Handyman Pocket Handbook.

**Shop Policy**

Read safety handouts provided, use common sense, maintain safe shop practices, keep your Lab clean, and orderly. Keep all safety shields/guards, and equipment in place at all times. Notify your Instructor of faulty wiring/equipment, worn or damaged tools, or missing parts. No horseplay is allowed whatsoever. Academic disciplinary measures will be promptly administered to offending person(s). Please help the Instructor to maintain order so that he can be free to use your time for more effective teaching, and less time housekeeping. We all can enjoy the benefits of an effective and conducive learning environment. Remember to use your safety glasses when entering the shop area. Always perform proper Lock-out / Tag-out.

**Tools, Equipment, and Clothing**

Students shall wear appropriate clothing to perform any work task assigned. Tools and equipment specified for this class and any recommended preliminary class in the Nondestructive Testing and Evaluation curriculum are to be furnished by the student. Failure to dress for work or bring needed equipment may count as an absence. All tools should be properly used and cared for, thus allowing for longevity and safety of both the user and the tool.
Supplies

**Tools:** Safety Glasses, PPE, Scientific Calculator, Tool Kit, Three-Ring Notebook, Tools Per Department List, Storage Media, Handyman Pocket Reference, Flashlight, Vernier Calipers, Tape Measure.

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**Required ASNT Student Membership and Appropriate Standards**

All classes require the relevant ASNT - Personal Training Publication applicable to the testing method being studied.

**Textbooks**

HANDYMAN IN-YOUR-POCKET
Young/Glover
Published by Sequoia
ISBN 1-885071-29-9

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http://www.asnt.org/index.html

http://www.asnt.org/membership/forms/individualmemaihtml - Student Membership - $15

http://asnt.org/shop/merchant.html?id=5&step=2 - Textbooks

http://astm.org/MEMBERSHIP/MemTypes.htm - Student Membership - Free

http://astm.org/studentmember/campusstandards.html - Student $10 Standards

http://www.ndt-ed.org/index_flash.htm - Education Resources
Measuring the Focal Spot Size

To develop an understanding of the effective focal spot size of the X-ray generator, have students determine its size. The measurement can be made from a radiograph produced using a flat piece of lead with a small pinhole in it. The image is produced in a mode similar to that of an old box camera. The following is a general procedure for making the measurement, and a more detailed procedure can be found in ASTM E1165.

1. Put a small pinhole in a lead sheet of sufficiently thickness to stop all of the radiation. The smaller the pinhole, the sharper the image.

2. Position the lead sheet directly perpendicular to X-ray beam and exactly half way between the X-ray tube target and the film. Center the pinhole in X-ray beam. This step is very important so use a string, level, plumb bob or other tools to make sure the sheet and hole are properly aligned.

3. Set the X-ray generator amperage (mA) relatively high and the energy (kV) relatively low to produce an exposure where few make it past the lead sheet except through the hole. Try not to saturate the radiograph in the region of the hole.

4. *Expose and develop the film.

5. Measure the diameter of the focal spot image on the film.
ASTM Std's Used in NDT Labs

ASNT Level II Radiographic Testing Syllabus

Objectives:

Terminal Objective-

Given instruction on principles of radiography, manufacturing processes, relevant standards, and specific applications, perform typical radiographic examinations in accordance with industrial Codes and in compliance with Regulatory Agency radiation safety requirements.

Enabling Objectives-

➢ Radiographic Viewing
  o Film-illuminator requirements
  o Background lighting
  o Multiple-composite viewing
  o Penetrometer placement
  o Personnel dark adaptation and visual acuity
  o Film identification
  o Location markers
  o Film-density measurement
  o Film artifacts

➢ Application Techniques
  o Multiple-film techniques
    ▪ Thickness variation parameters
    ▪ Film speed
    ▪ Film latitude
  o Enlargement & Projection
  o Geometrical relationships
  o Geometrical unsharpness
    ▪ Penetrometer sensitivity
    ▪ Source-to-film distance
    ▪ Focal-spot size
  o Triangulation methods for discontinuity location
  o Localized magnification
  o Film handling techniques

➢ Evaluation of Castings
  o Casting method review
  o Casting discontinuities
  o Origin & typical orientation of discontinuities
  o Radiographic appearance
  o Casting codes/standards – applicable acceptance criteria
  o Reference radiographs or pictograms
ASTM Stds Used in NDT Labs

➢ Evaluation of Weldments
  o Welding method review
  o Welding discontinuities
  o Origin & typical orientation of discontinuities
  o Radiographic appearance
  o Welding codes/standards – applicable acceptance criteria
  o Reference radiographs or pictograms

➢ Standards, Codes, and Procedures for Radiography
  o ASTM E 1742, Standard Practice for Radiographic Examination
  o ASTM E 999, Standard Guide for Controlling the Quality of Industrial Radiographic Film Processing
  o ASTM E 1032, Standard Test Method for Radiographic Examination of Weldments
  o ASTM E 2002, Standard Method for Determining Total Image Unsharpness in Radiology
  o ASTM E 1165, Standard Test Method for Measurement of Focal Spots of Industrial X-ray Tubes by Pinhole Imaging
  o ASTM E 1030, Standard Test Method for Radiographic Examination of Metallic Castings
  o ASTM E 1570, Standard Practice for Computed Tomographic (CT) Examination
  o ASTM E 1441, Standard Guide for Computed Tomography (CT) Imaging
  o AWS D1.1, Structural Welding Code – Steel
  o API 1104
  o ASME BPV:
    ▪ Section V, Article 2
    ▪ Section VIII
    ▪ Section IX
    ▪ Section I
  o Acceptable radiographic techniques & setups
  o Applicable industrial sector procedures
  o Procedure for radiographic parameter verification
  o Radiographic data report forms
ASTM Stds Used in NDT Labs

UT Level I Fall 2007 Lab

1. Thickness measurement

   E 797-95  Measuring Thickness by Manual Ultrasonic Pulse-Echo Contact Method

UT Level II Spring 2008 Labs

1. AWS D1.1 calibration and examination at 0 degrees and shear wave. Write calibration report.

2. ASME Section V DAC curve.

3. API RP2X calibration, beam characterization, DAC, transfer correction and beam shape report.

4. Flaw sizing of lab samples.

ASTM zero degree contact; angle beam and contact, immersion zero degree reports.

   • E 114-95  Ultrasonic Pulse-Echo Straight-Beam Examination by the Contact Method
   • E 1001-99a Detection and Evaluation of Discontinuities by the Immersed Pulse-Echo Ultrasonic Method Using Longitudinal Waves
   • E 587-00  Ultrasonic Angle-Beam Examination by the Contact Method
   • E 164-97  Ultrasonic Contact Examination of Weldments
   • E 1901-97 Detection and Evaluation of Discontinuities by Contact Pulse-Echo Straight-Beam Ultrasonic Methods

Flaw sizing after ASTM calibration.

Transducer characterization and comparison with manufacturers data sheet for one quarter, one half, one inch transducers.
Catholic University of America
School of Engineering
Engineering Management Program

Strategic Standardization Curriculum

(CMGT 564 - 2008)

The purpose of Strategic Standardization is to create a level of awareness, or enhance awareness, for graduate engineering students on significant issues associated with standards and the process of standardization. To a significant degree, a practicing engineering must successfully manage these issues in order to resolve complex engineering challenges. In particular, the course focuses on development of global technology standards from a United States perspective because the process of globalization directly affects the fields of engineering and technology management.

Standards govern the design, operation, manufacture, and use of everything mankind produces. There are standards to protect the environment, human health, safety, and to mediate commercial transactions. Other standards ensure that different products are compatible when hooked together. There are even standards of acceptable behavior within a society. Standards generally go unnoticed. They are mostly quiet, unseen forces, such as specifications, regulations, and protocols that ensure that things work properly, interactively, and responsibly. How standards come about is a mystery to most people should they even ponder the question. With the evolution of global markets, standards are even more important to facilitate international trade. Unfortunately, they may also be used as trade barriers or to gain advantage over foreign competitors. The United States has been fortunate to have a pluralistic, industry-led standards setting process that has served us well in the past. Whether it will continue to do so in the future in the face of bruising international economic competition is uncertain (Global Standards: Building Blocks for the Future, Forward, U.S. Office of Technology Assessment Report to Congress (1992)).

Globalization is rampant and will remain so for the foreseeable future. (The World is Flat, Thomas Friedman (2005)). Standards influence everything we do (UK National Standards Strategy (2003)). Standards control markets (German National Standards Strategy (2005)). Standardization is one of the best sources of competitive intelligence available (Canada National Standards Strategy (2005)). Standardization programs offer one of the best, most important means to evaluate current technology, and provide a glimpse of where future technology innovations may occur. Standardization programs are indispensable for the strategic evaluation of technology and the analysis of competitive issues. In strategic terms, "If you control an industry’s standards, you control that industry lock, stock, and ledger" (Out of the Crisis, by W. Edwards Deming, Center for Advanced Engineering Study, MIT at 302 (1986)).

1 http://www.princeton.edu/~ota/ns20/pubs_f.html
2 http://www.thomasfriedman.com/worldisflat.htm
4 http://www.din.de/sixcms_upload/media/2896/DNS_english%5B1%5D.pdf

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For over 100 years, the National Standards Policy of the United States has been the private sector will lead in the development of consensus standards and the government will play a supporting role (National Technology Transfer and Advancement Act (1995)). The United States standardization system is the most diverse standardization system in the world. According to the U.S. Department of Commerce, there are at least 600 individual standardization groups in the United States representing virtually industry in commerce. The United States System is a “bottom up” system in which the private sector has the leading role. All other national standardization systems are essentially “top down” systems in which the government has the leading role. At the global level, IEEE estimates that 500,000 technology standards are the technology foundation for the global economy, and it costs at least $1.5 billion each year to maintain the global standardization system.

Standards are created by various procedures and methods such as de facto systems (private sector), de jure systems (private sector and government), and consortia. There are a number of legal issues in standardization systems. In fact, the general environment in which standards are created resembles a complex legal maze. Legal issues include, for example, openness, fairness, public review, safety, health, the environment, competition, antitrust, intellectual property, trade and export controls, the internet, and ethics. The failure of practicing engineers to understand standards, the process of standardization, and potential legal issues related to these issues is unacceptable and may lead to significant liability for engineers and organizations that employ them.

The future of the United States economy depends, in significant part, on effective management of its standardization system and effective participation in development of international standards. It is estimated that at least 50% of current U.S. standards practitioners will retire in the foreseeable future. Standards education and training of the next generation of practitioners is a critical issue.

There is a clear need in the United States for greater attention to standards. In an information-based global economy, where standards are not only employed strategically as marketing tools but also serve to interconnect economic activities, inadequate support for the standards setting process will have serious detrimental effects. (U.S. Office of Technology Assessment, Global Standards: Building Blocks for the Future, at page 9)

In short, “[w]e have a republic if we can keep it...” (Benjamin Franklin).

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Faculty

Donald E. Purcell, Chairman, The Center for Global Standards Analysis, Washington, DC. Adjunct Faculty: Catholic University School of Engineering for Strategic Standardization; Catholic University School of Law for Cyber Law. Partner, Purcell & Fox LLP. Telephone: 202/531-0551; email: donpurcell@strategicstandards.com; web site: www.strategicstandards.com.

Curriculum

1. **Global standards are a bridge to the future [May 21]**
   - Strategic Standardization Overview (Purcell)
     - Definitions: Standards & Standardization
     - Globalization
     - “Global Standards – Building Blocks for the Future” (OTA Report 1992)
   - Strategic Value of Standards Education
     - Global Survey [Invitation to comment]
   - Grade: Research paper, presentation, attendance, participation & preparation.

2. **National Standards Strategies [May 28]**
   - National Standards Strategies Overview (Purcell)
     - United States
     - Canada
     - Germany
     - Japan
     - United Kingdom

3. **United States Standardization System (Private Sector) [June 4]**

   **Guest Speaker: Jean-Paul Emard, Director, Industry Forums (ATIS)**

   - Overview (Purcell)

4. **United States Standardization System (Public Sector) [June 11]**
   - Overview (Purcell)
   - United States Constitution
   - National Technology Transfer and Advancement Act
   - OMB Circular A-119
   - Relationship between private sector and public sector standards

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5. **Standards & Trade [June 18]**

   **Guest Speaker:** Jeff Weiss, Office of United States Trade Representatives

   - International Standards Overview (Purcell)
   - Definitions (What is an international standard?)
   - Organizations (What is an international standards organization?)
   - "Standards & Trade – Who Cares?" (NIST Speech)
   - Standards & Open Standards Systems (European Competition Commission Speech)

6. **Standards & Trade [June 25]**

   **Guest Speaker:** Bryan O’Byrne, International Trade Administration

   - International Standards &Trade Overview (Purcell)
   - Standards and Competition
   - World Trade Organization & United Nations

7. **Legal & Ethics Issues [July 2 – moved to Thursday July 3]**

   **Guest Speaker:** Stephen Lowell, Defense Standardization Office, U.S. Department of Defense

   - Legal and Ethics Overview (Purcell)
   - Health, safety and the environment
   - Antitrust & trade regulations
   - Intellectual Property

8. **Strategic Value of Standardization [July 9]**

   **Guest Speaker:** James Thomas, President ASTM International

   - Overview (Purcell)

9. **Testing, Certification and Conformity Assessment [July 16]**

   **Guest Speaker:** Gordon Gillerman, U.S. National Institute of Standards and Technology

   - Testing, Certification, Conformity Assessment

10. **Strategic Standards Management [July 23]**

    **Guest Speaker:** William E. Kelly, P.E., Ph.D. (former Dean, Catholic University School of Engineering)
11. 8 Class Presentations [July 30]

12. 8 Class Presentations [August 6]

Grade

**Research Paper (90%)**: A student may select any research topic related to standards or standardization approved by faculty. The research topic must be approved by June 30. The paper must be 15-20 pages in length and double spaced, not including title page, table of contents or attachments. Footnotes and citations must be appropriate for graduate research. The paper is due on the first day of examinations. Note: *please review the research paper writing samples.*

**Class Presentation (10%)**: The class presentation must be a power point presentation which lasts 10-15 minutes and is based upon the research paper.

**Discretionary points**: attendance (1 point), participation (1 point), preparation (1 point)
CVE 421/521 Behavior and Properties of Concrete  
Fall, 2008 (Revised)

Instructor: N. J. Delatte, P.E., Ph.D.  
Office: Stillwell Hall 121, Phone: 687-9259, Internet: n.delatte@csuohio.edu  
Prerequisite: none

Catalog description: CVE 421/521 Behavior and Properties of Concrete (3-0-3)  
Properties of hydraulic cements, aggregates, plastic, and hardened concrete; effect of admixtures and curing conditions; specifications and acceptance tests; placement, consolidation, finishing, and durability of concrete.

Grading system: 

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<td>10 %</td>
<td>10 %</td>
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<tr>
<td>Project –</td>
<td>N/A</td>
<td>10 %</td>
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<tr>
<td>Two Exams – each</td>
<td>30 %</td>
<td>25 %</td>
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<tr>
<td>Final Exam –</td>
<td>30 %</td>
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Course Objectives: At the conclusion of this course, you should be able to:  
1. Discuss cement properties, specifications, manufacture, and hydration  
2. Discuss aggregate properties and specifications  
3. Discuss and evaluate results of tests on fresh concrete  
4. Discuss and evaluate results of tests on hardened concrete  
5. Design concrete mixtures by the absolute volume method  
6. Discuss handling, placing, finishing, and curing concrete  
7. Discuss deformation and volume stability of concrete  
8. Discuss durability of concrete  
9. Discuss nondestructive testing and repair of concrete  
10. Design special concrete types – FRC, HPC, etc.

Notes:  
ACI web site http://www.concrete.org/general/home.asp  
To sign up for free student e-Membership: http://www.concrete.org/students/join.htm  
Spell out the school as Cleveland State University  
PCA web site http://www.cement.org/  
ASTM web site http://www.astm.org/  

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Class meets on Tuesdays and Thursdays from 4:00 – 5:15 or 6 p.m. in SR 398

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<td>Cement types and manufacture II</td>
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</tr>
<tr>
<td>9</td>
<td>Tuesday</td>
<td>23</td>
<td>Proportioning concrete mixes I</td>
<td>Chapter 10</td>
</tr>
<tr>
<td>10</td>
<td>Thursday</td>
<td>25</td>
<td>Chemical admixtures – Dr. Nmai guest</td>
<td>Chapter 8</td>
</tr>
<tr>
<td></td>
<td>Tuesday</td>
<td>30</td>
<td>Exam I</td>
<td>Chapters 1 – 10</td>
</tr>
<tr>
<td>11</td>
<td>Thursday</td>
<td>10/2</td>
<td>Proportioning concrete mixes II</td>
<td>Chapter 10</td>
</tr>
<tr>
<td>12</td>
<td>Tuesday</td>
<td>7</td>
<td>Concrete construction practices*</td>
<td>Chapter 11</td>
</tr>
<tr>
<td>13</td>
<td>Thursday</td>
<td>9</td>
<td>Concrete curing</td>
<td>Chapter 12</td>
</tr>
<tr>
<td>14</td>
<td>Tuesday</td>
<td>14</td>
<td>Stress and deformation</td>
<td>Chapter 13</td>
</tr>
<tr>
<td>15</td>
<td>Thursday</td>
<td>16</td>
<td>Hardened concrete properties and tests</td>
<td>Chapter 14</td>
</tr>
<tr>
<td>16</td>
<td>Tuesday</td>
<td>21</td>
<td>Quality control</td>
<td>Chapter 15</td>
</tr>
<tr>
<td>17</td>
<td>Thursday</td>
<td>23</td>
<td>Time-dependent deformation</td>
<td>Chapter 16</td>
</tr>
<tr>
<td></td>
<td>Tuesday</td>
<td>28</td>
<td>No class – OTEC in Columbus, Ohio, <a href="http://www.oteohio.org">www.oteohio.org</a></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Thursday</td>
<td>30</td>
<td>High-strength/high performance concrete</td>
<td>Chapter 19</td>
</tr>
<tr>
<td></td>
<td>Tuesday</td>
<td>11/4</td>
<td>No class</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Thursday</td>
<td>6</td>
<td>Concrete for special applications</td>
<td>Chapter 20</td>
</tr>
<tr>
<td>19</td>
<td>Tuesday</td>
<td>11</td>
<td>Cement-polymer composites, FRC</td>
<td>Chapters 21, 22</td>
</tr>
<tr>
<td>20</td>
<td>Thursday</td>
<td>13</td>
<td>Guest lecture/ special topic</td>
<td>Chapters 11 – 22</td>
</tr>
<tr>
<td></td>
<td>Tuesday</td>
<td>18</td>
<td>Exam II</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Thursday</td>
<td>20</td>
<td>Guest lecture/ special topic</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Tuesday</td>
<td>25</td>
<td>Project presentations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tuesday</td>
<td>12/2</td>
<td>No class</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thursday</td>
<td>4</td>
<td>No class</td>
<td></td>
</tr>
<tr>
<td>Final</td>
<td>Tuesday</td>
<td>9</td>
<td>Final exam 4 – 6 p.m.</td>
<td>All</td>
</tr>
</tbody>
</table>

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Homework on ASTM Standards

Due at start of class Tuesday 25 November – 5 homework bonus points. Include the ASTM standard number, date, and section where you found the answer.

1. There is a safety warning for the slump test – what is it? The warning also shows up on other tests.

2. When two different operators conduct the air content test of fresh concrete by the pressure method, what is the maximum difference in percent air that should be expected?

3. What is the single-operator-machine multibatch precision for the static modulus of elasticity test, over the range of 2.5 to 4 million psi?

4. What is the expected within-batch coefficient of variation for the splitting tensile strength test, and what is the maximum expected variation of two properly conducted tests?

5. How many cylindrical test specimens must be prepared to develop a maturity-strength relationship?

6. When making concrete test specimens in the field, what is the initial curing temperature range if the concrete specified strength is 6000 psi or greater?

7. What is the within-test precision for the compressive strength test on 4 x 8 cylinders?

8. What is the single-operator coefficient of variation for drilled cores with compressive strength between 4500 and 7000 psi?

9. What is the single-operator coefficient of variation for flexural strength of concrete beams with third-point loading?

10. For the unit weight test, what are the requirements for the rubber mallet for a sample of less than one half cubic foot?
Food Science 410 - Sensory Evaluation
Food Science Department
New York State College of Agriculture and Life Sciences
Cornell University Ithaca, NY 14853

Sensory evaluation is an important but poorly understood scientific discipline that is central to the development of creative and nutritious food products. I hope that you will learn new concepts in Food Science and that together we will have good discussions.

Course Description:
This course deals with the sensory techniques used in evaluating the flavor, color and texture of foods and the evaluation of consumer acceptance. This includes methods for measuring sensory qualities, underlying psychological principles, statistical methods for analyzing results, and how a full-service sensory evaluation program operates in a processed foods company.

Goals:

1) To familiarize students with the test methods involved in discrimination, descriptive analysis and consumer sensory testing of food products.
2) To examine the types of statistical analyses used to summarize sensory data and to draw conclusions and make recommendations about product characteristics.
3) To understand principles of physiology, psychology and measurement upon which methods of sensory testing are based.
4) To understand how a sensory evaluation provides important information in the product development process.
5) To enhance your scientific and business communication skills.

Prerequisite: one semester of statistics.
Evaluation: There are statistics problem sets, a mid-term and final
Lab: There are weekly lab writeups, a group project and oral presentation.


NOTE: The laboratory section of the course is optional except for Food Science majors. If the lab section is elected, you will receive one additional credit.

Format: Lectures, T-Th 9:05, room 124 Stocking Hall.
Lab: Friday, 1:25 room 124 Stocking Hall.

Instructor: Harry Lawless, htl1@cornell.edu
Teaching Assistant: Luciana Ferreira, fraufereira@gmail.com

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# Food Science 410: Sensory Evaluation

Lecture: Stocking Hall 124. Tuesday and Thursday: 9:05 – 9:55 am  
Lab: Stocking Hall 124. Friday: 1:25 – 4:25 pm

## Lecture Schedule

<table>
<thead>
<tr>
<th>Unit</th>
<th>Date</th>
<th>Lecture Topic</th>
<th>Reading</th>
<th>Problem Sets</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Aug 27</td>
<td>Introduction and overview</td>
<td>Chapter 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elements of good practice</td>
<td></td>
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<tr>
<td>2</td>
<td>Sept 1</td>
<td>ASTM STP 913 and MNL 60, ASTMBoS Volume 15.08</td>
<td>Chapter 3</td>
<td>#1 given</td>
</tr>
<tr>
<td>3</td>
<td>Sept 3</td>
<td>Historical roots; Psychophysics</td>
<td>pp. 29-39</td>
<td></td>
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<tr>
<td>4</td>
<td>Sept 8</td>
<td>Simple difference testing</td>
<td>Chapter 4</td>
<td>#1 due; #2 given</td>
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<tr>
<td>5</td>
<td>Sept 10</td>
<td>Equivalence Testing</td>
<td>(cont'd)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Sept 15</td>
<td>Signal detection</td>
<td>Chapter 5</td>
<td>#2 due; #3 given</td>
</tr>
<tr>
<td>7</td>
<td>Sept 17</td>
<td>Threshold tests</td>
<td>Chapter 6</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Sept 22</td>
<td>Scales and ratings</td>
<td>Chapter 7</td>
<td>#3 due, #4 given</td>
</tr>
<tr>
<td>9</td>
<td>Sept 24</td>
<td>Context effects</td>
<td>Chapter 9</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Sept 29</td>
<td>Time-intensity scaling</td>
<td>Chapter 8</td>
<td>#4 due</td>
</tr>
<tr>
<td>11</td>
<td>Oct 1</td>
<td>The sense of taste</td>
<td>pp. 39-75</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Oct 6</td>
<td>The sense of smell</td>
<td>(cont'd)</td>
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<tr>
<td></td>
<td>Oct 8</td>
<td>The trigeminal senses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Oct 15</td>
<td>Prelim (Midterm exam)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Oct 20</td>
<td>Descriptive analysis</td>
<td>Chapter 10</td>
<td>#5 given</td>
</tr>
<tr>
<td>15</td>
<td>Oct 22</td>
<td>QDA and Spectrum techniques</td>
<td>(cont'd)</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Oct 27</td>
<td>Catch up Day! TBA.....ANOVA?</td>
<td>#5 due; #6 given</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Oct 29</td>
<td>Texture profile</td>
<td>Chapter 11</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Nov 3</td>
<td>Acceptance and preference testing</td>
<td>Chapter 13</td>
<td>#6 due; #7 given</td>
</tr>
<tr>
<td>19</td>
<td>Nov 5</td>
<td>Alternatives to acceptance testing</td>
<td>Chapter 14</td>
<td>#7 due</td>
</tr>
<tr>
<td>20</td>
<td>Nov 10</td>
<td>Consumer tests</td>
<td>Chapter 14</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Nov 12</td>
<td>Sensory quality control</td>
<td></td>
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</tr>
</tbody>
</table>

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Food Science 410: Sensory Evaluation
Lecture: Stocking Hall 124. Tuesday and Thursday: 9:05 – 9:55 am
Lab: Stocking Hall 124. Friday: 1:25 – 4:25 pm

20 Nov 17 Shelf life tests
22 Nov 19 Focus groups
23 Nov 24 Color and appearance testing
24 Dec 1 Perceptual mapping and category reviews
26 Dec 3 Sensory Evaluation – Current Research
# Tentative Lab Schedule

<table>
<thead>
<tr>
<th>Lab</th>
<th>Lab Title</th>
<th>Date</th>
<th>Report Due Date</th>
<th>Report Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab 1</td>
<td>Basic Laboratory Practices</td>
<td>Aug 28</td>
<td>Sept. 4</td>
<td>10</td>
</tr>
<tr>
<td>Lab 2</td>
<td>Screening Tests and Sensory Acuity</td>
<td>Sep 4</td>
<td>Sep 11</td>
<td>10</td>
</tr>
<tr>
<td>Lab 3</td>
<td>Comparison of Discrimination Test Methods</td>
<td>Sep 11</td>
<td>Sep 18</td>
<td>10</td>
</tr>
<tr>
<td>Lab 4</td>
<td>Forced Choice Thresholds Measured by Ascending Method of Limits ASTM E 679</td>
<td>Sep 18</td>
<td>Sep 25</td>
<td>10</td>
</tr>
<tr>
<td>Lab 5</td>
<td>Signal Detection Theory</td>
<td>Sep 25</td>
<td>Oct 2</td>
<td>10</td>
</tr>
<tr>
<td>Lab 6</td>
<td>Sweetness of Fructose and Sucrose Determined by Magnitude Estimation and Category Scaling</td>
<td>Oct 2</td>
<td>Oct 9</td>
<td>10</td>
</tr>
<tr>
<td>Lab 7</td>
<td>Exploration of the Time Intensity Method using Compusense (tentative)</td>
<td>Oct 9</td>
<td>Oct 16</td>
<td>5</td>
</tr>
<tr>
<td>Lab 8</td>
<td>Introduction to Computerized Data Collection</td>
<td>Oct 16</td>
<td>(no report)</td>
<td>--</td>
</tr>
<tr>
<td>Lab 9</td>
<td>Flavor Profile</td>
<td>Oct 23</td>
<td>Oct. 30</td>
<td>5</td>
</tr>
<tr>
<td>Lab 10</td>
<td>Descriptive Ballot Development and Term Generation</td>
<td>Oct. 30</td>
<td>(no report)</td>
<td>--</td>
</tr>
<tr>
<td>Lab 11</td>
<td>Descriptive Analysis /Shelf life testing</td>
<td>Nov 6</td>
<td>Nov 13</td>
<td>10</td>
</tr>
<tr>
<td>Lab 12</td>
<td>Optimization by <em>ad libitum</em> Mixing and the Just-About-Right Scale</td>
<td>Nov 13</td>
<td>Nov. 20</td>
<td>10</td>
</tr>
<tr>
<td>Lab 13</td>
<td>MRE Questionnaire design</td>
<td>Nov. 20</td>
<td>(no report)</td>
<td></td>
</tr>
<tr>
<td>Lab 13</td>
<td>Group Project Reports</td>
<td>Dec 4</td>
<td>Dec 11</td>
<td>50</td>
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</tbody>
</table>
Course Description: This course provides a broad overview of the arena for international business, and the impact of the international business environment on management decision-making in the different functional areas of business. We begin with a look at the rapid changes that have taken place in international trade and investment over the past decade. Then we address the role of international institutions and the international monetary system. An in-depth study of the external environmental influences on the business arena precedes the final section on how business decisions are made in the international arena given the different external environmental forces. We will also increase our knowledge of world geography and the different regions of the world. Finally, students will have the opportunity to become experts in doing business in one foreign country of their choice.
Eastern University
BUSA 306 International Business
Spring 2012

Instructor: Phillip Thomas
Phone: 484-897-0868
Email: phillip.thomas@gmail.com

Course Description: This course provides a broad overview of the arena for international business, and the impact of the international business environment on management decision-making in the different functional areas of business. We begin with a look at the rapid changes that have taken place in international trade and investment over the past decade. Then we address the role of international institutions and the international monetary system. An in-depth study of the external environmental influences on the business arena precedes the final section on how business decisions are made in the international arena given the different external environmental forces. We will also increase our knowledge of world geography and the different regions of the world. Finally, students will have the opportunity to become experts in doing business in one foreign country of their choice.

Required Text:
• Other Readings distributed in class

Course Objectives:
Upon completion of this course, the student will be able to:
• Discuss the changes and trends in the arena of international business
• Articulate different perspectives of the globalization debate.
• Understand and explain the changes in international trade and in foreign direct investment.
• Identify the role and power of international institutions.
• Explain the history of and the current characteristics of the international monetary system.
• Discuss the impact of socio-cultural forces on international business.
• Explain why a business managers need to consider the natural environment and sustainability in making international business decisions
• Identify the economic forces that impact international business
• Explain the importance of government stability and country risk analysis in international business.
• Explain rule of law and the legal forces affecting international business.
• Discuss the role of foreign exchange markets and financial forces affecting international business.
• Explain labor mobility and labor force productivity, and the labor influences on international business.
• Discuss different entry modes for international business as well as import/export strategy.
• Show how the different functional areas for business (strategic planning, marketing, finance, organizational design and human resource management, and operations) are challenged when expanding to the international arena.
• Examine the role that faith plays (and should play) in international business decisions.
Course Expectations:
You are expected to come to class having read the assigned chapters, with your chapter questions finished, and relevant article analyses. Written questions will only be accepted at the beginning of each class. No late homework will be accepted. If you need to miss class, please send me an email 4 hours prior to class. You may send homework in with a classmate, or via email, only if I determine that your absence is excused. **We will have 4 quizzes (see * in schedule). There will be one mid-term and one final exam.**

Assignments and Grading:
Chapter questions: (10 weeks X 10 points per week) 100 points
Class Participation: (10 weeks X 5 points per week) 50 points
Current Article and Comments: (10 weeks X 5 points per week) 50 points
Quizzes 100 points
Country Presentation (group) 300 points
Mid-term 200 points
Final exam 200 points
Total points 1000 points

Final course grade:
930-1000 = A
900-929 = A-
870-899 = B+
830-869 = B
800-829 = B-
770-799 = C+
730-769 = C
700-729 = C-
670-699 = D+
630-669 = D
600-629 = D-
below 600 = F

Country Presentation in Groups:
In groups of 4-5, you will choose a BRIC (Brazil, Russia, India, China) country and do research on the forces that affect doing business in that country. Your group will do a 10-15 minute presentation to the board of directors of a given company, convincing them why it is advisable to do business in that country. Make your presentation both informative and creative, using a variety of visual aids. Please choose your groups by week 3 of the semester (More guidance on this assignment will be given as we discuss the material in chapters 6-12.)

Class Participation:
Students are expected to do their readings and participate in classes. In addition, students are expected to find 1 (one) news article or commentary that deals with the topic(s) that is to be discussed in class. In addition, we will often do case studies, and a student’s participation in the case studies will determine the class participation grade. Each week’s class participation accounts for 10 points per week (5 points for the article and 5 points for direct class participation). Please hand me a print-out of the article that you will reference in class, along with the brief commentary on why the article is relevant to the topic, with your name printed on the top. The commentary does not need to be more than 4-5 sentences, and the article must not be more than 3 months old.
**Chapter Questions:**
These assignments will prepare you for class discussion and for the exams, and are also where most of your individual learning will take place, so please put in the time necessary to do a good job on these. All answers must be typewritten. You should be doing about 8 hours of work each week outside of class with your reading, chapter questions, group project, and outside research for the course. Each week answers will account for 10 points per week. Please read the minicases in italics (below). Whenever time is available we will try and do them as well.

**Schedule:**

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Read/Answer questions in ( )</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 18</td>
<td>Introduction to International Business</td>
<td>Ch. 1</td>
</tr>
<tr>
<td>January 25</td>
<td>International Trade and FDI</td>
<td>Ch. 2 (2)</td>
</tr>
<tr>
<td></td>
<td>Theories of International Trade</td>
<td>Ch. 3 (9)</td>
</tr>
<tr>
<td>February 1*</td>
<td>International Institutions</td>
<td>Ch. 4 (4)</td>
</tr>
<tr>
<td></td>
<td>Socio-cultural Forces</td>
<td>Ch. 5 (5)</td>
</tr>
<tr>
<td>February 8</td>
<td>Natural resources and Sustainability</td>
<td>Ch. 6 (8)</td>
</tr>
<tr>
<td></td>
<td>Economic and Socio-Economic Forces</td>
<td>Ch. 7 (7)</td>
</tr>
<tr>
<td></td>
<td><em>Read Minicase 7.1 and prepare for discussion</em></td>
<td></td>
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<tr>
<td>February 15</td>
<td>Political Forces</td>
<td>Ch. 8 (2)</td>
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<tr>
<td></td>
<td>IP and Legal Forces</td>
<td>Ch. 9 (4)</td>
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<td></td>
<td><em>Read Minicase 9.1 and prepare for discussion</em></td>
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<tr>
<td>February 22*</td>
<td>Intl. Monetary System/Financial Forces</td>
<td>Ch. 10 (3)</td>
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<tr>
<td></td>
<td>Labor Forces</td>
<td>Ch. 11 (2)</td>
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<td></td>
<td><em>Read Minicase 11.1 and prepare for discussion</em></td>
<td></td>
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<tr>
<td>February 29</td>
<td>International Competitive Strategy</td>
<td>Ch. 12 (1)</td>
</tr>
<tr>
<td></td>
<td>Review for Mid-term</td>
<td></td>
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<tr>
<td></td>
<td><em>Read Minicase 12.1 and prepare for discussion</em></td>
<td></td>
</tr>
<tr>
<td>March 14</td>
<td>Mid-term Exam</td>
<td></td>
</tr>
<tr>
<td>March 21</td>
<td>Organizational Design and Control</td>
<td>Ch. 13 (2)</td>
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<tr>
<td></td>
<td>Assessing and Analyzing Markets</td>
<td>Ch. 14 (1)</td>
</tr>
<tr>
<td></td>
<td><em>Read Minicase 14.1 and prepare for discussion</em></td>
<td></td>
</tr>
<tr>
<td>March 28*</td>
<td>Entry Modes</td>
<td>Ch. 15 (7)</td>
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<tr>
<td></td>
<td>Import/Export Practices</td>
<td>Ch. 16 (5)</td>
</tr>
<tr>
<td></td>
<td><em>Read Minicase 15.1 and prepare for discussion</em></td>
<td></td>
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<tr>
<td>April 4</td>
<td>Work on Country Projects</td>
<td></td>
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<tr>
<td>April 11</td>
<td>International Marketing</td>
<td>Ch. 17 (6)</td>
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<tr>
<td></td>
<td>Global Operations/ Supply Chain Management</td>
<td>Ch. 18 (2)</td>
</tr>
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<td></td>
<td>Answer questions in Minicase 18.1</td>
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<td></td>
<td><em>Read Minicase 17.1 and prepare for discussion</em></td>
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<tr>
<td>April 18*</td>
<td>Human Resource Management</td>
<td>Ch. 19 (1)</td>
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<tr>
<td></td>
<td>Intl. Accounting/Financial Management</td>
<td>Ch. 20 (2)</td>
</tr>
<tr>
<td></td>
<td><em>Read Minicase 19.1 and prepare for discussion</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Read Minicase 20.1 and prepare for discussion</em></td>
<td></td>
</tr>
<tr>
<td>April 25</td>
<td>Country Presentations</td>
<td></td>
</tr>
<tr>
<td>May 2</td>
<td>Final Exam</td>
<td></td>
</tr>
</tbody>
</table>
Teaching Philosophy:
Every class is based on the assumption that you have keenly read the chapters in question. The mode of teaching is class discussions, current events, case studies, videos, etc. If you do not keep up with the readings, articles and current business events, the class will not make sense. If there is something in the readings that you do not understand, please email me by 6 pm on the Sunday preceding the class. I will incorporate it into the lecture.

Grading Rubrics

Class Participation Rubric (Total = 5)

1. Show up for class with homework 1 pt.
2. Ask questions, respond to discussions 2-3 pts.
3. Active Participation 4-5 pts.

Article Grading Rubric (Total = 5)

1. Appropriateness to the topic 1 pt.
2. Current topic (within 3 months) 1 pt.
3. Commentary 3 pts.

Homework Grading Rubric (Each question= 5, Total = 10)

1. Direct and (not vague ) 2 pts.
2. Back up information, where necessary 1-2 pts.

Class Presentation (Total = 300)

1. Concise Executive Summary 25 pts.
2. Evidence of Research 25 pts.
6. Ability to connect all logical points 25 pts.
7. Quality of Presentation Materials 25 pts.
10. Ability to answer questions 25 pts.
11. Proving your thesis that product/service will work 25 pts.

Exam Essay Questions Grading Rubric (Total = 25)

1. Direct, clear answers 10
2. Back up information 7
3. Grammar, edits 8
UNIVERSITY OF RHODE ISLAND  
College of Human Science and Services  
TMD 403: Textile Performance

Good quality and serviceability requires that a textile product meet certain criteria, described in performance specifications. Specifications are based on laboratory testing. These tests are only useful if they are standardized. The most widely accepted tests for textile products are those developed by ASTM and AATCC.

The course examines how "quality" in textile materials may be judged, and how it may be predicted both by consumer perceptions and by the results of real-life trials and laboratory tests. The development of both product specifications and test methods is discussed. Achieving reliable test data, and the statistical handling of that data are dealt with. Test methods in the areas of characterization, strength and elongation, wear, colorfastness, appearance, flammability, absorbency and aesthetics will be critically compared.

At the end of this course, the student will understand quality in textile products and the methods to assess it. The student will be familiar with the development of specifications and test methods by Government, Trade Associations and Industry. The student will be able to carry out procedures for routine testing of established products. More importantly, the student will be able to develop plans for sample selection and testing, and to set up procedures to determine the effects of treatments on fabric properties in non-routine testing.

The course should be of value to all TMD and TM majors since it directly affects all areas of the textile product supply chain: designers should be able to specify requirements, while buyers, merchandisers and marketers will need to see that products will meet their customer needs. Process and product development in all phases of the textile industry is based on the ability to measure improvement, in turn based on the use of testing. The global nature of the textile supply chain makes standard testing essential if satisfactory materials are to reach the stores. There is a continuing demand for graduates of TM and TMD who know product testing and quality control.
TMD 403: Textile Performance  
INSTRUCTOR: Dr. Martin Bide  
TEXT: "Textile Testing and Analysis", Collier and Epps (Merrill/Prentice Hall 1999) Required

THE COURSE
> Is a required course for Textile Marketing majors, and an upper-level elective for majors in Textiles, Fashion Merchandising and Design. Prerequisites for the course are TMD 303, and TMD 313 (or permission of the instructor).

CLASS FORMAT
The class meetings will include lectures, group discussions and laboratory exercises.

POLICIES
Since this is a small course, attendance is essential and your contribution to discussion is required. You are responsible for making up any lost time, and the degree of sympathy you get if you need help will be in proportion to the amount of effort (attendance, participation) you have applied. This is especially true when applied to the use of laboratory time.

GRADES
There will be three exams during the semester and a final exam (cumulative). Later exams and the final will be take-home. Laboratory work will be divided into two sections. The first is "routine testing" and relates to the hands-on aspects of the routine tests discussed in class. A summary report will be required for this. The second relates to a short project that you will design and carry out. This will be explained in more detail later in the semester. Some homework exercises will be assigned.

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<tr>
<td>3 Exams @ 50 Pts</td>
<td>150</td>
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<tr>
<td>1 Final</td>
<td>100</td>
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<tr>
<td>Lab report (routine testing)</td>
<td>100</td>
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<tr>
<td>Project Proposal</td>
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<td>Project Report</td>
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<td>Homework Assignments</td>
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<td><strong>Total</strong></td>
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Semester averages of 90% will earn A grades, 80-90% will earn B's, 70-80% will earn C's and 60-70% will earn D's. These limits may be reduced, but will not be increased.

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SYLLABUS

Subject to Change, although the topics listed follow the chapters in the text quite closely. Approximately half the semester will be spent in the lab: it is not practical, however, to decide beforehand that one session a week will be lab and one will be class.

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic:</th>
<th>Notes:</th>
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<tbody>
<tr>
<td>1</td>
<td>Introduction. Quality</td>
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<td>2</td>
<td>Standard Specifications. Reliability in testing</td>
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<td>3</td>
<td>Sampling and Statistics</td>
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<td>4</td>
<td>Testing Overview</td>
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<td>5</td>
<td>Fabric Characterization</td>
<td>Exam 1</td>
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<td>6</td>
<td>Fabric Strength/elongation [No class Monday!]</td>
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<td>7</td>
<td>Abrasion and wear</td>
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<td>8</td>
<td>Effects of refurbishment</td>
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<td>9</td>
<td>Colorfastness Tests</td>
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<td>10</td>
<td>Colorfastness: End-use Exposure</td>
<td>Exam 2</td>
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<td>11</td>
<td>Flammability</td>
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<td>12</td>
<td>Absorbancy/Repellency</td>
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<td>13</td>
<td>Comfort, Hand, Drape</td>
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<tr>
<td>14</td>
<td>Conclusions</td>
<td>Exam 3</td>
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</table>

Final exam
As part of this course you will plan and carry out a short group project based on some aspect of the course content. In the past the Clorox Company sponsored two projects, we designed a potential new test method to evaluate sun protective value of clothing and we spent three years doing projects based on stain repellent finishes for a commercial company. We have also worked on a project to develop a new abrasion test for the US Army. On two occasions, the project has been developed into a paper submitted to AATCC’s Student Paper Competition.

* The group(s) will need to develop…..
1. The plan.
   A clear statement of what you are trying to demonstrate, or what question you are trying to answer. In detail, the tests you plan to carry out: what equipment you’ll use, how many samples you will test, what you will do with the results from the tests…..
2. The background.
   Has anyone done this before? What’s going on? What might you expect to happen? Provide some references!
3. The implementation
   Doing the tests. Did you plan well, organize logically!?
4. Analysing the results
   What do the results mean? Can you explain them?
5. Writing a report.
   Can you explain 1-4 clearly, logically, sensibly?

What kind of project?? Here are some ideas that might give you inspiration.

- Is a particular test relevant? Does it reproduce what it is supposed to? Example: AATCC has a test for colorfastness to laundering which uses a single cycle. It is designed to simulate the effect of 5 home launderings. Does it??
- A particular test is not relevant. For certain fabrics/uses, the test does not predict what happens in practice. Can you develop a test that does? (Example: pilling in army battledress).
- I plan to apply a finish to a textile: will it significantly affect the performance? Does it actually do what it is supposed to do? This finish is supposed to reduce wrinkling without releasing formaldehyde. What tests will support this claim? What tests might be needed to see if there are any negative side effects?
- How big a color difference can be tolerated within the various components that make up a garment? What color scale should be used? Does the answer vary from color to color?
- The standard test for wash fastness uses a certain type of detergent. What is the effect of changing the detergent type?
- This fabric is used for making sails. It’s wonderful when first manufactured, but what will happen after sun and salt water get on it for a season of sailing?
- I can get the same color on the fabric using three different types of dye: which method is least damaging to the fabric properties?
- Find a range of similar but different fabrics (factors such as yarn count, fabric count, fiber type, weave structure, fabric weight should be considered). Which of these parameters affects abrasion resistance the most? Tensile strength? etc.
MECH-580 Properties of Polymers
Summer Term 2002
(Required in Specialty)

2002 Catalog Data: Credit: (4-0-4) Four Lecture-Hours
Prerequisites: Senior II Standing; MECH-200, Introduction to CAE;
MECH-212, Mechanics II; MFGG-370, Engineering Materials

This course begins with thermo-mechanical properties of commodity
thermoplastics and includes a review of structure/nomenclature. The
course then addresses: polymer shape and size, amorphous and
crystalline states, $T_g$, $T_m$, rubber elasticity and viscoelasticity (creep).
There will be materials’ selection and design projects.


References:
1. Polymer Engineering and Science,
2. Prospector® (web based plastic materials data base)
3. IDEAS® tutorials

Coordinator: Charles C. Davis

Course learning objectives:

Upon completion of the course the student will be able to:

1. List thermo-mechanical properties of commodity thermoplastics. [ME PO’s: A, G, K]
2. Draw structures and give names for selected thermoplastics. [ME PO’s: A, G, K, P]
3. Estimate CED, modulus, specific volume and $T_g$ from structure. [ME PO’s: A, KP]
4. Correlate free volume with $T_g$ [ME PO’s: A, K, P]
5. Estimate crosslink density from the shear modulus. [ME PEO’s: A, E, K, M, P]
6. Derive an apparent modulus from creep data. [ME PO’s A, E, K, M, P]

Prerequisites by topic:

1. IDEAS (or equivalent) skills.
2. Basic PC skills (word processing, spreadsheet and web).
3. Organic nomenclature.
4. Analysis of stress & deformation (solid body mechanics).

Topics covered:

1. Thermo-mechanical properties. [2 Weeks]
2. Structure-nomenclature [1 Week]
3. Thermoplastic material selection. [1 Week]
4. Polymer shape and size. [1.5 Weeks]
5. Amorphous and crystalline states. [2 Weeks]
6. Free volume, $T_g$ and $T_m$ [1 Week]
7. Rubber elasticity. [1.5 Weeks]
8. Viscoelasticity and creep [1 Week]

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purposes only. Any use of this material shall include attribution to its author,
Laura L. Sullivan, Ph.D., Kettering University, Flint, MI.
Schedule: Two 120-minute lecture sessions per week.

Computer usage: CAD drawings of all geometries. FEA simulations of loading. Plastic material data base searching.

Laboratory projects: N/A

Relationship to professional component: Two credits of Engineering Science and Two credits of Engineering Design.

Prepared by: Charles C. Davis

Date: 11/01/02
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<th>Topic</th>
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<td>1</td>
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<td>1. Polymer Synthesis and Architecture</td>
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<td>1.1. Molecules and Monomers</td>
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<td>1.3. Condensation Polymerization</td>
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<td>1</td>
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<td>1.5. Stereosomerism</td>
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<td>1.6. High Polymer Degree of Polymerization</td>
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<td>2</td>
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<td>HOLIDAY - NO CLASSES</td>
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<td>2</td>
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<td>1.7. Molecular Forces - Primary and Secondary bonding</td>
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<td>1.8. Thermoplastics and Thermosets</td>
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<td>1.9.1. Polymers with C only in backbone</td>
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<td>1.9.2. Polymers with N in backbone</td>
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<td>1.9.3. Polymers with O in backbone</td>
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<td>1.9.5. Copolymers</td>
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<td>2. Polymer Characterization</td>
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<td>2.1. Molecular Weight</td>
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<td>2.2. Polydispersity</td>
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<td>2.3. Methods for Determining Molecular Weight</td>
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<td>2.3.1. Colligative measurements</td>
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<td>3. Molecular Order</td>
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<td>3.1. Polymer Crystallinity</td>
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<td>3.1.3. Configurations and Conformations</td>
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<td>3.1.4. Crystal Growth</td>
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<td>3.1.5. Spherulites</td>
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<td>3.1.6. Effect of Temperature and Cooling Rate</td>
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<td>3.1.7. Melting Temperature</td>
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<td>3.2.1. DSC</td>
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<td>3.2.2. Cross Polarized Microscopy</td>
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<td>3.2.3. Birefringence</td>
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<td>5</td>
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<td>3.3. Amorphous Polymers</td>
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<td>3.3.1. Structure</td>
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<td>3.3.2. Glass Transition Temperature</td>
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<td>3.4. Polymer transitions</td>
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<td><strong>4. Mechanical Behavior</strong></td>
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<td>4.1. Deformation and viscoelastic behavior</td>
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<td>4.1.5. Linear viscoelastic models</td>
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<td>4.3. Yield and Ductility</td>
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<td>4.4. Fracture</td>
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<td>4.5. Impact Toughness</td>
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<td><strong>Exam Two</strong> — Topic 3: Molecular Order, and Topic 4: Mechanical Behavior</td>
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<td><strong>6. Testing for Design</strong></td>
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<td>6.1. Fluid Properties</td>
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<td>6.1.1. Melt index [ASTM D1238]</td>
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<td>6.1.2. Rheometry</td>
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| 9    | M   | 3/5  | 6.2. Solid Properties  
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6.2.2. Flexural behavior [ASTM D790]  
6.2.3. Compressive behavior (rigid plastics) [ASTM D695]  
6.2.4. Poisson’s Ratio behavior  
6.2.5. Hardness [DIN 53.456] and its relationship with yield  
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6.2.10.1. Creep testing [ASTM D2990]  
6.2.10.2. Time-temperature superposition  
6.2.11. Fatigue behavior [ASTM D671]  
6.2.12. Environmental Stress Cracking [ASTM 1693]  
| 10   | M   | 3/12 |  
| 10   | R   | 3/15 |  
| 11   |     |      | **PROJECT: PRESENTATIONS**  
| Final exam period | Exam Three – Topic 5: Flow Behavior, and  
|                  | Topic 6: Testing for Design  

Grades will be calculated as follows:  
Three Exams, 20% each  
Group Project, 25%  
Homework, 10%  
Participation*, 5%  

60%  
25%  
10%  
5%

There will be NO make-up exams!  
A COMPREHENSIVE make-up exam will be offered outside of class during 11th week.

*Other than exams, I expect that much of the work that you do in this course will be done with a group. I will use the Participation portion of your grade to handle situations where a group member is not carrying his/her load in the group.
MECH 580
Winter, 2009
PRODUCT TESTING SPECIFICATIONS

Provide a WRITTEN Standard Testing Procedure for each of your products, to include:

1. Description of product
   - Include product photo, all dimensions, and any material identification

2. Description of service environment for product
   - What mechanical, thermal, and chemical stresses would be experienced by polymer product during lifetime under “normal” use.
   - What mechanical, thermal, and chemical stresses would be experienced by polymer product during lifetime under “extreme” conditions.

3. Description of test set-up
   a. Environmental conditions (these are typically held constant throughout the test, and include temperature, pressure, humidity, any presence of chemicals that could potentially affect the test results.
   b. Discuss the relationship between the environmental conditions recommended for the test and the environmental conditions seen in service.
   c. List all equipment that is used in the test, including devices used to measure dimensions and mass (as necessary).
   d. Include list of all constants (temperature, load signature, chemical environment). There may be information in this section that is the same as information in section 3a.
   e. Provide an illustration of test set up.
   f. Provide a list of independent variables. These are the “stresses” that will be applied to the product, such as concentration of a solvent, magnitude and orientation of a force or moment, and/or temperature. These are the variables that you CONTROL during the test.
   g. Provide a list of dependent variables. These are things such as extent of deformation or strain under stress, extent of deformation or strain after stress is removed (sometimes as a function of time), deformation on the surface (as a result of scratch test or hardness test, length of cracks formed, discoloration or change in surface texture*.
   i. Describe manner in which test data should be provided – provide a data sheet for the test teams to fill out.
   j. Identify ASTM test standards that align with the properties you are testing, and discuss the similarities and differences between your test procedure and the ASTM test standards you have noted.

*extent of discoloration or changes in surface texture are difficult to quantify. For this type of evaluation, you should provide the test teams with a visual scale that they can used to “quantify” changes.
Product Test Development

You have been provided with a sample product. In this document, you'll also be provided with information regarding the mechanical, chemical; and thermal environments experienced by this product in service. You will also be provided information about the mode(s) of failure for this product. Your task is (1) to develop a standard test procedure for this product, (2) to correlate your procedure to standard ASTM tests, as described below, and (3) to relate the behavior of your product to mechanical and thermal behaviors of polymers (see FOLLOWUP QUESTIONS).

Product: Ice cube tray

Service Environment:

Mechanical Stresses: This product will experience mechanical torsion and bending stresses necessary to loosen ice from the tray.
Thermal stresses: This product can see temperatures ranging from 15-200 F.
Chemical Stresses: Citric and acetic acid present in fruit juices, detergents

Failure modes of concern: An increasing number of ice cube trays are being returned from retail stores, due to numerous cracks occurring (see locations A and B above). Failure is being noted during shipment and storage, as well as during customer use.
Assignment:
I. Develop a test procedure that would capture the mechanical behavior of your product in service and that would allow for the detection of inferior quality.
   1. Include a description of the test equipment and setup.
   2. Include a step-by-step description of the test procedure.

II. Identify one ASTM standard test procedure that correlates with the procedure you have developed. Discuss how data from this ASTM test on a polymer could be correlated to your product test data.

III. FOLLOWUP QUESTIONS:
   1. Assuming that your product is manufactured from a semicrystalline polymer, how would the level of crystallinity affect the mechanical behavior of your product?

   2. If your product were manufactured from an amorphous polymer, how would this affect the mechanical behavior of the product?

   3. Is the polymer from which your product is manufactured above or below its glass transition temperature?

   4. Describe a circumstance in which your product could exhibit viscoelastic behavior. Describe the Hookean nature of the product's behavior, and describe the viscous nature of the product's behavior.
Product Test Development

You have been provided with a sample product. In this document, you'll also be provided with information regarding the mechanical, chemical, and thermal environments experienced by this product in service. You will also be provided information about the mode(s) of failure for this product. Your task is (1) to develop a standard test procedure for this product, (2) to correlate your procedure to standard ASTM tests, as described below, and (3) to relate the behavior of your product to mechanical and thermal behaviors of polymers (see FOLLOWUP QUESTIONS).

Product:

Service Environment:

Mechanical Stresses: This product may experience mechanical torsion and bending stresses during packaging and shipment, as well as by end user following purchase.
Thermal stresses: This product can see temperatures ranging from 15-350 °F.
Chemical Stresses: This product can be exposed to a wide range of materials, including (but not limited to) detergents and acids.

Failure modes of concern: An increasing number of these spatulas are being returned from retail stores, due to deformation and failure at locations A and B (see above).
Assignment:
I. Develop a test procedure that would capture the mechanical behavior of your product in service and that would allow for the detection of inferior quality.
   1. Include a description of the test equipment and setup.
   2. Include a step-by-step description of the test procedure.

II. Identify one ASTM standard test procedure that correlates with the procedure you have developed. Discuss how data from this ASTM test on a polymer could be correlated to your product test data.

III. FOLLOWUP QUESTIONS:
   1. Assuming that your product is manufactured from a semicrystalline polymer, how would the level of crystallinity affect the mechanical behavior of your product?

   2. If your product were manufactured from an amorphous polymer, how would this affect the mechanical behavior of the product?

   3. Is the polymer from which your product is manufactured above or below its glass transition temperature?

   4. Describe a circumstance in which your product could exhibit viscoelastic behavior. Describe the Hookean nature of the product’s behavior, and describe the viscous nature of the product’s behavior.
1.035 MECHANICS OF STRUCTURES AND SOILS
FALL SEMESTER 2009
(5-3-10)

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SCHEDULE:
Lectures: MTWR 1:00 – 2:00 Room 1-273
Laboratory T or F 2:00 – 5:00 Room 1-050
Recitation: F 1:00 – 2:00 Room 1-273

OBJECTIVES:
The main aims of this subject are:
1. To learn and apply methods of structural analyses for beams, columns, frames, cables and arches.
2. To develop an understanding of the behavior and engineering properties of construction materials (principally steel and concrete), soils and rocks (natural geomaterials).
3. To gain physical insights into material behavior through an integrated program of laboratory experiments.
4. To learn and apply principles of soil mechanics used in analysis of foundations, earthworks, retaining structures and slopes.
5. Develop an appreciation of techniques and approximations used in structural and geotechnical engineering.

ORGANIZATION:
The course is sub-divided into three main modules:
• The first module deals with engineering properties of materials including mechanisms of brittle and ductile failure, creep and fatigue; phase diagrams and control of engineering properties of alloy steels. This section also introduces the chemistry of cements, constituents and mix design to control hydration reactions and strength of concrete.
• The second module covers the analyses of determinate and indeterminate structures including beams, plates, columns, cables and arches. The presentation includes fundamental principles and concepts, such as free-body diagrams, energy principles, Maxwell-Betti reciprocity law and matrix methods of structural analysis. The composite
behavior of reinforced concrete sections are introduced along with the principles of pre-stressing.

- The third module introduces soils, their classification and phase relations; groundwater seepage, pore pressures, effective stresses and consolidation theory. Shear strength properties are related to drainage conditions within the soil mass and linked to the bearing capacity of foundations, limiting lateral earth pressures and stability of slopes; while deformation properties of soils are related to foundation settlements.

**LECTURE NOTES:**
Extensive class notes, supplementary materials and PowerPoint presentations will be posted at regular intervals in the course’s web site ahead of the classes. It can be found at http://stellar.mit.edu/S/course/1/fa09/1.035/

You are expected to check the web site periodically, download the lecture notes, problem sets or lab assignments, print them as may be appropriate, and bring them to class or lab for further annotations. This will greatly help you in decreasing the volume of notes taken during classes and allow you more time for listening and comprehension.

**TEXT:**
No single text covering the whole subject of this course exists or is available, but we do require you to buy the textbook on Soil Mechanics indicated below. Still, with the large number of lecture notes that we hand out, a book is not really necessary, except for Soil Mechanics. Useful additional references that may be borrowed from the library are as follows:

1) **Structural analysis**
   T. Au and P. Christiano, Fundamentals of Structural Analysis, Prentice Hall

2) **Materials:**
   S. Somayaji: *Civil Engineering Materials*, Prentice Hall
   M.S. Mamlok, J.P. Zaniewski: *Materials for Civil and Construction Engineering*, Addison-Wesley

3) **Soils:**
   R.F. Craig: *Soil Mechanics* (on reserve at MIT library)
   A. Verruijt: *Soil mechanics*, available for free at http://geo.verruijt.net/
   T.W. Lambe and R.V. Whitman: *Soil Mechanics*, e-version available on Stellar
   J.T. Germaine and A.V. Germaine: *Geotechnical Laboratory Measurements*
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<tr>
<th>Week</th>
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<td>Course Intro. &amp; Admin., Intro to CE materials</td>
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<td></td>
<td></td>
<td>Thurs. Sept. 10</td>
<td>Materials: Review of equilibrium, stress, strain, elasticity, Mohr circle</td>
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<td>2</td>
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<td>Materials: Mechanism of ductile and brittle failure, yielding</td>
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<td>Tues. Sept. 15</td>
<td>Materials: Creep &amp; fracture toughness</td>
<td>1a Measurements</td>
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<td>Wed. Sept. 16</td>
<td>Materials: Fatigue &amp; corrosion</td>
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<td>EK</td>
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<td>Tues. Sept. 22</td>
<td>Materials: Steel alloys and treatments</td>
<td>2a Strength properties</td>
<td>Lab1a</td>
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<td>Wed. Sept. 23</td>
<td>Materials: Concrete: Constituents &amp; mixes, hydration properties</td>
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<td>PS#2</td>
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<td>Thurs. Sept. 24</td>
<td>Materials: Concrete: Mech. Properties, durability</td>
<td>2b Strength properties</td>
<td>Lab1b</td>
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<td>4</td>
<td>EK</td>
<td>Mon. Sept. 28</td>
<td>Structures: Static equilibrium, determinacy, boundary conditions, geom. stability</td>
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<td>Tues. Sept. 29</td>
<td>Struct: Structural loads &amp; resistance, symmetry, superposition, linearity</td>
<td>3a Conc. mix &amp; early age props</td>
<td>Lab2a</td>
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<tr>
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<td>Wed. Sept. 30</td>
<td>Struct: Analysis of determinate trusses. Method of joints</td>
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<td>PS#3</td>
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<td>Thurs. Oct. 1</td>
<td>Struct: Trusses: Method of sections. Introduction to cables</td>
<td>3b Conc. mix &amp; early age props</td>
<td>Lab2b</td>
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<td>Mon. Oct. 5</td>
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<td>Tues. Oct. 6</td>
<td>Struct: Internal equilibrium of beams and frames</td>
<td>4a Hardened concrete</td>
<td>Lab3a</td>
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<th>Date</th>
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<td>Wed. Oct. 7</td>
<td><strong>Struct</strong>: Stresses and deformations in beams, elastic vs. inelastic deformations</td>
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<tr>
<td>Thur. Oct. 8</td>
<td><strong>Struct</strong>: beam theory, moment area method</td>
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<td>Mon. Oct. 12</td>
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<td>EK Tues. Oct. 13</td>
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<td><strong>Lab4a</strong></td>
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<tr>
<td>Wed. Oct. 14</td>
<td><strong>Struct</strong>: Conjugate beam, method of slope deflection</td>
<td><strong>PS#4</strong></td>
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<td>Thurs. Oct. 15</td>
<td><strong>Struct</strong>: Energy principles, Castigliano theorems</td>
<td><strong>3b Buckling</strong></td>
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<td>7 EK Mon. Oct. 19</td>
<td><strong>Struct</strong>: principle of virtual force, Maxwell-Betti law</td>
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<td>Tue. Oct 20</td>
<td><strong>Struct</strong>: rectangular concrete beams &amp; reinforcement, bending vs. shear</td>
<td><strong>5a Buckling</strong></td>
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<td>Wed. Oct 21</td>
<td><strong>Struct</strong>: concrete beam-slab interaction (T-sect), composite sect</td>
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<td>Thurs. Oct 22</td>
<td><strong>Struct</strong>: Pre-stressed concrete</td>
<td><strong>6b RC beam bending</strong></td>
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<td>Fri. Oct 23</td>
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<td>8 EK Mon. Oct. 26</td>
<td><strong>Struct</strong>: Approximate methods of analysis</td>
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<td>Tues. Oct 27</td>
<td><strong>Struct</strong>: Approximate methods of analysis</td>
<td><strong>6a RC beam bending</strong></td>
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<td><strong>7b Soil classification</strong></td>
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<td>9 EK Mon. Nov. 2</td>
<td><strong>Struct</strong>: Intro. matrix methods</td>
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<td>Tues. Nov 3</td>
<td><strong>Struct</strong>: Final review</td>
<td><strong>7a Soil classification</strong></td>
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<td>RJ Thurs. Nov. 5</td>
<td><strong>Soils</strong>: Constituents &amp; classification</td>
<td><strong>8b Seepage and Effective Stress</strong></td>
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<td>10 RJ Mon. Nov. 9</td>
<td><strong>Soils</strong>: Phase relations</td>
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<td>Tue. Nov. 10</td>
<td><strong>Soils</strong>: Pore pressure &amp; effective stress</td>
<td><strong>8a Seepage and Effective Stress</strong></td>
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<td>Event</td>
<td>soils</td>
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<td>Soils: 1-D Seepage</td>
<td>9b Direct shear</td>
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<td>11 RJ</td>
<td>Mon. Nov. 16</td>
<td>Soils: Permeability</td>
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<td>Tues. Nov. 19</td>
<td>Soils: 2-D flow nets</td>
<td>9a Direct shear</td>
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<td>Drop Date</td>
<td>Wed. Nov. 18</td>
<td>Soils: 2-D flow applications</td>
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<td>Thur. Nov. 19</td>
<td>Soils: Mohr-Coulomb</td>
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<td>12 RJ</td>
<td>Mon. Nov. 23</td>
<td>Soils: Shear strength of sands</td>
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<td>Tues. Nov. 24</td>
<td>Soils: Drained bearing capacity &amp; earth pressures</td>
<td>10a Clay consolidation</td>
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<td>Wed. Nov. 25</td>
<td>Soils: Elastic stresses &amp; settlement</td>
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<td>Thur. Nov. 26</td>
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<td>13 RJ</td>
<td>Mon. Nov. 30</td>
<td>Soils: Sand stiffness properties &amp; settlement</td>
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<tr>
<td>Tues. Dec. 1</td>
<td>Soils: 1-D consolidation</td>
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<td>Wed. Dec. 2</td>
<td>Soils: 1-D consolidation</td>
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<td>Thur. Dec. 3</td>
<td>Soils: 1-D consolidation</td>
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<td>Fri. Dec. 4</td>
<td><strong>Recitation</strong></td>
<td>Lab 10 a</td>
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<tr>
<td>14 RJ</td>
<td>Mon. Dec. 7</td>
<td>Soils: Clay consolidation settlement</td>
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<td>Tues. Dec. 8</td>
<td>Soils: Undrained shear strength</td>
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<td>Wed. Dec. 9</td>
<td>Soils: Undrained stability</td>
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<td>Thur. Dec. 10</td>
<td>Soils: Slope stability</td>
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<td><strong>FINAL EXAM:</strong></td>
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CONTENTS OF LABS

1. Measurements
   - Force, pressure & displacement measurements
   - A/D conversion

2. Structural properties
   - Tension/modulus/yield/fracture – steel, carbon steel, glass, aluminum, cast iron
   - Heat treatment – quenching and preparation of carbon steel
   - Hardness & impact

3. Concrete mix constituents and early age properties
   - Mix proportions, admixtures
   - Slump test & descriptions

4. Hardened concrete
   - Uniaxial compression
   - Indirect tension

5. Concentrically-Loaded Columns
   - Compression Behavior
   - Elastic stability

6. Reinforced concrete beam
   - Over-reinforced
   - Under-reinforced

7. Soils classification
   - Atterberg limit tests
   - Grain size by hydrometer & sieving
   - Physical and index testing methods (physical meaning of index tests)

8. Soils – Seepage & effective stress
   - Hydraulic conductivity
   - Upward flow tank test

9. Soils – Shear strength
   - Direct shear box
   - Relative density & specimen preparation
   - Triaxial shear & unconfined compression

10. Soils – Consolidation
    - Oedometer step load test
POTENTIAL CONTENTS OF PROBLEM SETS

Structures and materials (EK)
1) Stresses & strains, Mohr circle
2) Fracture toughness & yielding
3) Phase diagrams
4) Steel & concrete properties
5) Reinforced concrete
6) Static equilibrium of trusses and frames
7) Deformations in beams, moment area method
8) Energy methods

Soils (RJ)
9) Soil properties
10) Seepage
11) Drained deformation & strength
12) Consolidation
13) Undrained shear & stability

QUIZZES
Quiz 1: Materials modules (EK)
Quiz 2: Structures modules (EK)

FINAL: Will be comprehensive, covering all aspects of this course
LABORATORY ASSIGNMENT NUMBER 10

CONSOLIDATION TEST

Purpose: You will learn about:
(1) one dimensional consolidation equipment
(2) consolidation behavior of cohesive soils
(3) relationship between drainage path and consolidation time
(4) difference between secondary compression and primary consolidation

Location: 1-050

Things you should know:
- Read this handout carefully
- Notes from Lecture on consolidation theory

Further Reading:
- ASTM D2435 on the consolidation test
- Lambe Chapter IX (a simple description of the test and interpretation)
- Lambe and Whitman Chapter 27 (presents the basic concept of consolidation theory)
- Germaine and Germaine Chapter 17 (a bit more detail on the interpretation)

Organization:
This laboratory is centered around performing and interpreting the consolidation test. A standard consolidation test takes about one week to perform so you will only participate in part of the data collection. The lab will be performed in two stations. At one station, you will apply one load increment, record the time deformation data, and perform the graphical constructions. You will be given an Excel template to help reduce the test data and we will review this template during the lab session. At the second station, you will learn how to process an undisturbed clay sample and set up the consolidation tests. The goals at this station are to give you some sense of the texture of the soil, a quick look at radiographs, measurement of undrained strength using the torvane, some practice trimming a clay specimen, and a physical connection to the data sheets.

Overview:
The consolidation test is the basic experiment to measure the settlement characteristics of a clay layer. The rate of consolidation is governed by a coupling between the hydraulic conductivity and the compressibility of the soil. During this laboratory, you will be conducting an incremental consolidation test on a specimen trimmed from an undisturbed sample of Boston Blue Clay. The standard oedometer test configuration is to have both top and bottom (double)
drainage. It takes from several days to a few weeks to perform a complete consolidation test. The test duration depends on the number of consolidation increments and the soil type (actually the value of the coupled parameter called the coefficient of consolidation). A typical commercial laboratory will invest as much as 20 hours of manpower to perform the test. This being the case, it is not possible for us to perform the complete experiment for class. The entire laboratory will be performed on one test specimen. Each group will perform two increments on the same specimen but at different stress levels. In addition to your laboratory sessions, we will setup the specimen, perform the rest of the increments, and give you the entire data set for analysis. You are to perform detailed calculations to compute the coefficient of consolidation, the hydraulic conductivity, and the rate of secondary compression on your two increments only. You are then to use the log time method to determine the end of primary strain for the rest of the increments and use the data from all the increments to compute the compression curve.

This handout outlines the proper procedure for performing the entire consolidation test. This additional information is to help you understand what was done throughout the test and is for your reference. We will also go through the process of selecting a sample, removing the soil from the tube, and trimming into the sample ring during the laboratory. The last page of this handout has instructions for the 1.035 assignment.

Procedure:

**Apparatus Calibration**

1. Assemble the oedometer (stones, filter screen and top cap) with a steel block in place of the soil specimen.
2. Align assembly in the loading frame.
3. Place a 1 lb seating load on the cell and obtain a zero reading on the displacement transducer.
4. Apply the same loads to the apparatus as will be used in testing the specimen.
5. At each load increment, record the displacement reading at 15 sec, 30 sec, 1 min, 2 min and 5 min.
6. The change in LVDT gives the machine deflection curve.

**Apparatus preparation**

1. Grease specimen ring and cutting shoe.
2. Determine the mass (Mₚ) of the empty specimen ring with one filter screen.
3. Measure the height (H₁) and diameter (D₁) of the ring.
4. Measure the thickness of one piece of filter screen (Hₛ₁).
5. Measure the thickness of the recess tool (ΔH₁).
6. Boil or ultrasound the stones for 10 minutes to clean and remove air.

**Specimen preparation**

1. Debond the soil from the inside of the sample tube with the wire cutter.
2. Using a plastic disc push the soil about 5 mm out of the tube.
3. Use a wire saw and the mitre box to cut the surface flat.
4. Push the soil completely out of the tube.
5. Place cut side of the sample on another plastic disc.
6. Rough cut the diameter with a wire saw to within 1/8" of final diameter.
7. Assemble sample in trimmer.
8. Trim sample with cutting shoe and spatula.
9. Once sample is completely fitted into specimen ring, trim bottom with a wire saw.
10. Trim top with wire saw and then finish surface with a sharp straight edge.
11. Place filter screen on top surface and use recess tool to create space at top of ring.
12. Trim excess soil from bottom with wire saw and make final cut with the sharp straight edge.
13. Obtain separate water contents from material taken from top and bottom cuts.
14. Determine the mass of the specimen and ring ($M_{sw}$).

**Apparatus assembly**
1. Fill base with water.
2. Insert bottom stone into base and cover with filter screen.
3. Remove excess water with a paper towel.
4. Place specimen and ring on stone.
5. Cover rim with gasket.
6. Tighten with locking ring.
7. Drain excess water from top stone and place on specimen.
8. Place top cap on stone.
9. Locate assembly in loading frame with LVDT and balance arms (this is the true weight of the assembly and corresponds to the tare load).
10. Set a one or two pound seating load (above tare load) on loading arm and zero displacement transducer.

**Consolidation test**
1. Consolidate the specimen using a load increment ratio ($\Delta P/P$) between 0.5 and 1.0 for loading and -0.25 and -0.50 for unloading.
2. Fill the water bath at about 1/4 the overburden stress or within 2 hours of the start of the test.
3. For each increment, record the displacement transducer reading versus time. Remember that the initial portion of the curve is very important and will define the start of consolidation ($\varepsilon_s$).
4. During each increment plot both square root time and log time curves.
5. After the end of primary consolidation has been reached for each increment, a subsequent load increment may be applied.

6. Allow one cycle of secondary compression to occur under the maximum load and before the unload-reload cycle.

7. Remove the water from the bath and remove the specimen from the apparatus.

8. Extrude the soil from the ring and obtain oven dried mass of soil.

Calculations:

The following provides a summary description of the basic equations that are necessary to complete the test. The attached pages provide the actual equations. I hope this makes the test reduction process easier to follow.

- **Initial Specimen Height** = \( H_r - \Delta H_i - H_{fp} \)
- **Initial Water Content** = (initial total mass – final dry mass)/ final dry mass
- **Void Ratio** = (total volume - volume of solids)/ volume of solids
- **Volume of solids** = mass of oven dried soil / (specific gravity (use 2.75) X mass density of water).
- **Degree of saturation** = specific gravity X water content / void ratio
- **Vertical effective stress** (\( \sigma' \)) (when the pore pressure is zero) = (Applied load - Tare load + top cap and stone)/ Area
- **Vertical strain** (\( e_v \)) = (measured axial deformation - Apparatus compression )/ Initial specimen height

Note: The Apparatus compression curve will be posted.

- **Compressibility** (a_v) = - change in void ratio / change in vertical stress

Note: change in void ratio is usually taken at the end of primary but for this laboratory assignment you can use end of increment values.

- **Coefficient of consolidation** (c_v).(root time) = 0.848 X (drainage height)^2 / time for 90% consolidation
- **Coefficient of consolidation** (c_v).(log time) = 0.197 X (drainage height)^2 / time for 50% consolidation

Note: Drainage height is computed at 50% consolidation for both cases.

- **Hydraulic conductivity** (k_v) = (coef. of consolidation X compressibility X unit weight of water) / (1 + void ratio)

Note: Void ratio is computed at 50% consolidation for the increment. c_v should be average value from the root time and log time methods.

- **Rate of secondary compression** (c_o) = change in strain per log cycle of time after primary is complete.
Report:

Your report should include the following information:

- All the hand recorded data sheets.
- A graph of vertical strain vs. root time and vs. log time for the two load increments applied during your laboratory session.
- Perform the construction for the coefficient of consolidation on each graph for these two increments (two log and two root time). Indicate the end of primary strain on the log time graph.
- For your two increments compute the following:
  - the void ratio at the point of 50% consolidation.
  - the compressibility ($a_v$).
  - the coefficient of consolidation ($c_v$).
  - the hydraulic conductivity ($k_v$).
  - rate of secondary compression ($c_s$)
- A graph of vertical strain ($e_v$) vs. log vertical stress ($\sigma_v$) indicating end of primary, $\bullet$, and end of increment, $\Delta$. Use the Log time method to determine the end of primary strain. Note: You will only have the end of primary points for your two increments. For the rest of the increments you only need to provide end of increment (the last data point) strain.
- Perform the construction for the preconsolidation pressure ($\sigma_p$) using the Casagrande construction.
- Additional information about the specimen.
  - initial specimen water content
  - initial void ratio
  - initial degree of saturation.
Middle Tennessee State University (MTSU)  
Concrete Industry Management (CIM) Program

This Program is a joint initiative between MTSU and leaders from the concrete industry. It provides students the opportunity to enter a field that has an urgent need for professionals with the skills to meet the growing demands of a progressive, changing concrete industry.

The four-year Bachelor of Science degree in Concrete Industry Management is offered by the Engineering Technology & Industrial Studies Department in the College of Basic and Applied Sciences.

The concrete industry played a major role in helping develop the curriculum for the CIM Program. Concrete professionals and industry consultants worked with MTSU administration to make sure the CIM Graduates are fully prepared. The degree is composed of four major areas of study: general studies requirements, required support courses, major requirements of concrete-related courses, and business courses.

The goal is to produce graduates who are:

- Broadly educated
- Adept at oral and written communication
- Proficient in basic math and science
- Knowledgeable of concrete technology and techniques
- Able to manage people and systems
- Capable of promoting products or services related to the industry.

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CIM 3000 Fundamentals of Concrete: Properties and Testing

CIM3000 examines effects of concrete-making materials (aggregates, cements, admixtures, etc.) on the properties of fresh and hardened concrete. Concrete mixture proportioning calculations and statistical analysis of strength tests are also studied.

Topics will include:
• aggregate properties and testing (grading, specific gravity, absorption, moisture content, abrasion resistance, soundness, harmful substances)
• cement properties and testing (chemical composition, fineness, setting time, soundness, strength)
• supplementary cementing materials (fly ash, silica fume, blast-furnace slag)
• admixtures (air-entraining agents, water reducers, accelerators, retarders)
• fresh concrete properties and testing (workability, slump, air content, unit weight)
• hardened concrete properties and testing (strength, durability, volume changes, permeability)
• concrete mix proportioning (normal strength, high strength, and special mixes)
• statistical analysis of concrete strength tests
• ACI Level I Field Testing Certification

CIM 4200 Senior Concrete Lab
ASTM's covered in course: C88, C157, C403, C490, C617, C642, C666, C845, C1202, C1585, C1579, C1688, C1701

CIM4200 provides students an opportunity to further develop their technical and laboratory knowledge and pursue a project of individual interest. A formal report/presentation will be required at the conclusion of the course.

Topics will include:
• advanced laboratory testing and field evaluation techniques
• individually guided project(s)
• ACI Level I Lab Certification

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Sustainability & International Standards

In the past decade, standards have assumed new prominence as an essential part of international commerce and the process of globalization. Many view the WTO, a relatively young institution, as one of the greatest engines of change today. The primary tools of this change are international standards. Some view the change as progress; others view the change as catastrophic. Regardless of your perspective, it is critical to understand the hidden life of international standards, how & why they are created, and their implications for sustainable development.

If you have ever tried to install a new piece of hardware on a computer only to be told that “it won’t work with your system,” tried to screw an American standard bolt into a hole with metric threads, or stared at a recipe while trying to figure out how many milliliters are in one third cup, you know the frustration of non-standardization. Standards affect all areas of life from the minute details of tasks such as cooking and shopping to global investments. It is difficult to imagine a sophisticated society without standards.

This course reviews the role of standards in the global economy and their potential impact on sustainable development. This is a survey course intended for graduate students. Although the course is primarily intended for students in the fields of environmental management, international studies, and business, it is available to any graduate student interested in this field of study, for example, law students, political science, and industry-sector specific programs. It is intended to provide graduate students with a broad understanding of the cross-functional and interdisciplinary issues associated with standards, the process of standardization and global governance.

READING REQUIREMENTS:
All required reading assignments will be available electronically. Additional recommendations for reading may be made as appropriate to Projects.

- Form and Style for ASTM Standards, "Blue Book" (PDF); last update 04/03; [http://www.astm.org/COMMIT/Blue_Book.pdf](http://www.astm.org/COMMIT/Blue_Book.pdf)
- Regulations Governing ASTM Technical Committees or "Green Book" (PDF); last update 06/03; [http://www.astm.org/COMMIT/Regs200204.pdf](http://www.astm.org/COMMIT/Regs200204.pdf)
- The WTO in Brief; [http://www.wto.org/english/thewto_e/whatis_e/inbrief_e/inbr00_e.htm](http://www.wto.org/english/thewto_e/whatis_e/inbrief_e/inbr00_e.htm)
- WTO legal texts (emphasis on Technical Barriers to Trade); [http://www.wto.org/english/docs_e/legal_e/legal_e.htm#tbt](http://www.wto.org/english/docs_e/legal_e/legal_e.htm#tbt)
- Standardization in a Global Marketplace: Process and Implications.
- The Multilateral Trade System: A Development Perspective.
- Highlights of the Standards Setting Process in Five Example Bodies; diagrams.
- Trade, Gender and Poverty.
- The Global Governance of Trade as if Development Really Mattered.
PAPERS:
Papers will be developed individually; estimate 1000 words. Individuals will be assigned an industry sector topic. Papers shall present an overview of the global market relative to the topic. Papers should discuss the topic in terms of aspects of sustainability (i.e. economic, environmental, social). Papers should include an executive summary and appropriate references/notations. It is expected that the projects will be of significant quality, and worthy of publication in a national or international standards publication.

Industry Sector Topics are as follows:

Agriculture, with an emphasis on:
- Genetically Modified Organisms (GMOs)
- Fair Trade
- Traditional Practices

Consumer Products, with an emphasis on:
- Labeling

Healthcare, with an emphasis on:
- Precautionary Principle
- Traditional Knowledge
- Toxicogenomics

Finance & Corporate Management, with an emphasis on:
- Corporate Social Responsibility
- Investment Screens for SRI
- Corporate Governance (e.g. Transparency of Organizations)
- Privacy of Individuals
- Real Progress Indicators (RPI vs GDP)

Energy, with an emphasis on:
- Climate Change
- Green Power
- Disaster Preparedness and Response

Water, with an emphasis on:
- Watershed Assessment & Monitoring
- Water Stewardship (management)
- Disaster Preparedness and Response

PROJECTS:
Projects will be developed individually. Individuals will be assigned an industry sector topic consistent with Paper Topic. Projects shall develop the following:

- PART 1. Identify existing standards and Standards Development Organizations (SDOs), if any relative to the topic; indicate the SDO and the SDO process, summarize the scope of each standard, and provide an assessment of the appropriateness of the standard in terms of its contribution to sustainable development. Discuss/organize standards in terms of aspects of sustainability.
- PART 2. Draft a standard relative to the topic in support of sustainable development.
- PART 3. Identify key stakeholders; prepare statement for each indicating who they are and why their expertise is appropriate. Indicate how their expertise is pertinent to each of the aspects of sustainability.
SYLLABUS:

WEEK 1:  
Topic:  Introduction & Overview of Course  
Discussion:  Sustainability in business, government and non-government organizations. Syllabus review.

WEEK 2:  
Topic:  Standards Development – Why?  
Discussion:  Why are standards important? What is sustainable development? What is the World Trade Organization (WTO) & how does it impact national economies and domestic policy. Overview of changing role of international standards in the global market in wake of WTO.  
Powerpoint:  Standards Development - Why  
Assignment:  Reading for next week - Standardization in a Global Marketplace: Process and Implications.

WEEK 3:  
Topic:  Standards Development – What, Who, and When?  
Discussion:  Are standards minimum requirements? Maximums? What is their purpose and who sets the standards? What are the implications (politically, economically, legally, environmentally, socially) for trade? How do these differ for local/global organizations? For developing/developed countries? What are the implications for sustainable development?  
Powerpoint:  Standards Development – What, Who, and When  
Assignment:  ASSIGNMENT OF PAPERS. Reading for next week: The Multilateral Trade System: A Development Perspective.

WEEK 4:  
Topic:  “Harmonization” and Technical Barriers to Trade (TBT)  
Discussion:  Focus on harmonization of standards – what is it, what are the pros and cons? Focus on TBT as it relates to harmonization. How does this impact developed countries? Developing countries? Local/municipal governments? Consumers? Industry?  

WEEK 5:  
Topic:  Trade and Human Development  
Discussion:  Examination of the current world trade regime through a human development lens while focusing on concerns expressed by developing country governments and a range of civil society organizations. Discussion of trade rules that may allow for diversity in national institutions and standards, including the impacts on local cultures and development priorities.  
Powerpoint:  Making Global Trade Work for People  
Assignment:  PROJECT ASSIGNMENTS. PART 1. Reading for next week – Highlights of the Standards Setting Process in Five Example Bodies; diagrams.

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WEEK 6:  
**PAPERS DUE.**

**Topic:** Discussion of Project Assignments.

**Discussion:** Changing society and its standards. Discuss from a variety of perspectives: technological, economic, legal, social. Comparison of standards (type and use) at the start of 20th century to standards today. Overview of the different industry sector topics and current events. What would happen if standards were created on the subjects listed? How might this affect sustainable development?

**Assignment:** Reading for Next Week: *Trade, Gender and Poverty.*

WEEK 7:  
**Topic:** Developed Countries & Developing Countries

**Discussion:** Different socio-economic priorities of Developed Countries & Developing Countries. Are countries homogenous? What is the feasibility of Developing Countries creating and supporting a national SDO system? What is the significance for standards development in ISO? ASTM? What are the unique issues, if any, for island nations? How are these reflected in the SDO process?

WEEK 8:  
**Break, no class**

WEEK 9:  
**PROJECT - PART 1 DUE.**

**Topic:** Standards Development – How?

**Discussion:** This is the mundane part of the course. However, it is necessary to understand the rules of the game in the new ‘post-WTO’ climate, so we will review USA standards development organizations (SDOs) and the International Organization for Standardization (ISO). How does the SDO process affect the potential for sustainable development?

**Powerpoint:** Standards Development – How?

**Assignment:** PROJECT ASSIGNMENTS. PART 2.

WEEK 10:  
**Topic:** Project Assignments.

**Discussion:** No lecture/discussion class; meetings w/instructors by appointment. Instructors to schedule time to focus on Projects – Part 2.

WEEK 11:  
**Topic:** Standards Development in ASTM International

**Discussion:** Overview of types standards and their uses. Presentation of sample standards related to sustainable development.

WEEK 12:  
**Topic:** Project Assignments.

**Discussion:** No lecture/discussion class; meetings w/instructors by appointment. Instructors to schedule time to focus on Projects – Part 2.

WEEK 13:  
**PROJECT - PART 2 DUE.**

**Topic:** ISO Tags and ASTM committees

**Discussion:** Real world examples of the ISO process and the ASTM process from the perspective of USA industry.

**Assignment:** PROJECT ASSIGNMENTS. PART 3. Reading for next week: Regulations Governing ASTM Technical Committees or "Green Book".
WEEK 14:  Topic: Resolution of Negatives
Discussion: Review of consensus process in SDOs and the required negotiations. What are the fundamental issues in each industry sector? Are there similarities? What stakeholders share common perspectives? Presentation of Projects to class for “ballot” and adjudication.

WEEK 15:  PROJECT - PART 3 DUE.
Topic: Resolution of Negatives (continued)
Discussion: Review of consensus process in SDOs and the required negotiations. What are the fundamental issues in each industry sector? Are there similarities? What stakeholders share common perspectives? Presentation of Projects to class for “ballot” and adjudication.
Assignment: Reading for next week: The Global Governance of Trade as if Development Really Mattered.

WEEK 16:  Topic: Review and Conclusions
Discussion: What is the big picture? How do the global governance institutions impact sustainable development? How are standards involved? What SDO processes can best promote sustainable development? What SDO process can most harm sustainable development? What industry sector topics most need standardization? What industry sector topics should NOT be standardized?
Properties of Engineering Materials II
Department of Materials Science and Engineering

This is a required departmental course, but is also appropriate for biomedical engineers and other engineering disciplines as an elective. This course teaches the mechanical properties of metals, ceramics, and polymers from both the macroscopic and atomistic or micromechanical viewpoints. An introduction to three-dimensional stresses and strains. Elastic behavior, plastic behavior, strengthening mechanisms, fracture, creep, and fatigue are all addressed. Includes laboratory component. Prerequisites: Materials Science for Engineers, Structure of Engineering Materials.
Properties of Materials II (Mechanical Properties of Materials), Spring 2009
Prof Linda S. Schadler

Class Hours: Monday 10:00-11:50  Office Hours: Mon, Thurs 9-10am
Lab, Wed 10:00-2:00  Teaching Assistant: Steve Mayott
Thursday 10:00-11:50  TA Office Hours: TBA

Text: "Mechanical Behavior of Materials" Meyers and Chawla
My expectation is that you will have read the textbook before coming to class.
This is difficult material to learn and some repetition is a good thing! I will only
assign the most relevant reading, but there is lots of good supplemental reading in
this book.

Format: The course will have ~3 hours of lecture per week and 2 hours of laboratory = 4
credits. I'm not sure why they always schedule the 4 hours of lecture, but I try
not to use it! That means, I am usually available from 11:30 -12:00 for questions
and it is a time when the lab groups can meet to compare data, etc.

I will "lecture" on a topic for the day, but this will be broken up with class
discussion, and problem solving

Tests: There will be three two-hour exams during the term (and now and then a lab
quiz to make sure you are reading the labs before coming to class!)

Laboratory: There will also be a teaching assistant to help during laboratory sessions. A
laboratory schedule and discussion of grading policy / plagiarism / safety is
attached. The reports will be handed in individually. If you don't understand
the format of the report, please clarify that early in the semester. At the end of the
term you will work with a team on a four-five week problem. You will be asked
to choose a material from the pile of materials I have. Then you will be asked to
strengthen the material. The results of this work will be an oral presentation to
the class during the last two classes and a group written report.

Homework: You will receive several homework assignments (about one every other week).
They can be completed collaboratively, but each student should hand in one set of
answers. If you collaborate with people please list their names on your
homework. Each student should understand every question that they hand in even
if they have received help on it.

Grading: Laboratory Reports 20%
Strengthening Experiments 20%
Homework 10%
Three two-Hour exams 30%
Final Exam (3 hour mandatory) 20%

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Linda S. Schadler, Ph.D, Rensselaer Polytechnic Institute, Troy, NY
<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Reading</th>
<th>Outcomes – Students should be able to</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 25</td>
<td>1. Introduction to Mechanical Properties</td>
<td>Text 1.3.1-1.3.5</td>
<td>• Complete tensile tests according to ASTM standards and understand sources of error</td>
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<tr>
<td></td>
<td>Review of Material from ENGR 1600</td>
<td>required. whole</td>
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<td></td>
<td>2a. Tensile Testing at the macroscale</td>
<td>chapter is helpful,</td>
<td></td>
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<td></td>
<td>Lab-Jan 27</td>
<td>Text 2.1, 2.2</td>
<td></td>
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<td></td>
<td>Lab Safety and Procedures</td>
<td></td>
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<tr>
<td></td>
<td>Lab #1 - Tensile Testing of Metals and Polymers (FULL REPORT DUE Feb 10)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>First Data uploaded by Feb 4</td>
<td></td>
<td></td>
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<tr>
<td>Jan 28</td>
<td>2. Analyzing Data from the Instron</td>
<td>Lab Manual</td>
<td>• Calculate Young’s modulus, yield stress, ultimate strength, ductility, strain to failure from tensile test results.</td>
</tr>
<tr>
<td></td>
<td>HOMEWORK #1 DUE</td>
<td>Text 3.1, 3.2</td>
<td>• Understand the difference between engineering stress and true stress</td>
</tr>
<tr>
<td>Feb 1</td>
<td>3. Definition of 3D Stress and Strain Transformation of Stresses</td>
<td>Text 2.2-2.8</td>
<td>• Determine engineering stress and strain from force and displacement</td>
</tr>
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<td></td>
<td>Part 2 of Lab #1 – Finish any testing and Microscopy of samples. Data</td>
<td>Lab Manual</td>
<td>• Have observed in an optical microscope tensile fracture surfaces of a metal and two polymers.</td>
</tr>
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<td>Feb 3</td>
<td>upload by Feb 4!!</td>
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<td>Feb 4</td>
<td>4. Hooke’s Law for anisotropic materials</td>
<td>Text 2.9, 2.10,</td>
<td></td>
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<td></td>
<td>Anisotropic moduli</td>
<td>Handout</td>
<td>• Understand that stress is 3D and that there are stress invariants</td>
</tr>
<tr>
<td>Feb 8</td>
<td>5. Atomic view of elasticity</td>
<td>Text 2.17</td>
<td>• Be able to use Young’s modulus, bulk modulus, Poisson’s ratio to relate stress to strain</td>
</tr>
<tr>
<td></td>
<td>3 and 4 point bending</td>
<td></td>
<td>• Be able to transform a stress matrix using Mohr’s circle and tensors</td>
</tr>
<tr>
<td></td>
<td>HOMEWORK #2 DUE</td>
<td></td>
<td>• Differentiate between hydrostatic and deviatomic stress and calculate dilatational strain</td>
</tr>
<tr>
<td>Feb 10</td>
<td>Lab #2 - Tensor Transformations</td>
<td>Lab Manual</td>
<td>• Apply Hooke’s Law for a 3D stress and strain state</td>
</tr>
<tr>
<td></td>
<td>(Worksheet Due Feb 17)</td>
<td></td>
<td>• Find the stress in a plane of a single crystal</td>
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<td></td>
<td></td>
<td></td>
<td>• Predict Young’s modulus,</td>
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<tr>
<td>Date</td>
<td>Activity</td>
<td>Text References</td>
<td>Notes</td>
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<tr>
<td>Feb 11</td>
<td>6. Viscoelasticity and Rubber Elasticity</td>
<td>Text 2.12-2.14</td>
<td>• Develop the equations for a small combination of springs and dashpots and predict the model behavior</td>
</tr>
<tr>
<td>Lab - Feb 16</td>
<td>Scanning Electron Microscopy and Metallography Training</td>
<td></td>
<td>• Describe the limitations of Hooke’s law for some materials</td>
</tr>
<tr>
<td>Lab-Feb 17</td>
<td>Lab #3 - Strain Rate Effects in Polymers (FULL REPORT Due Mar 3)</td>
<td>Lab Manual + Book</td>
<td>• Describe the role of entropy in the deformation of rubbers</td>
</tr>
<tr>
<td></td>
<td>Data uploaded FEB 24</td>
<td></td>
<td>• Determine Tg from DMA data</td>
</tr>
<tr>
<td>Feb 18</td>
<td>7. Plastic deformation and criteria</td>
<td>Text 3.1-3.2, 3.5, 3.7.1-3.7.4, 3.7.6</td>
<td>• Predict plastic deformation for complex stress states.</td>
</tr>
<tr>
<td>Feb 22</td>
<td>8. Hardness Testing, compression testing</td>
<td>Text 3.3, 3.4, 3.8</td>
<td>• Be able to apply craze criteria</td>
</tr>
<tr>
<td>Lab-Feb 24</td>
<td>Lab #4 Compression Testing of Composites (SHORT REPORT Due March 17)</td>
<td>Lab Manual</td>
<td>• Apply power law work hardening and calculate n</td>
</tr>
<tr>
<td></td>
<td>Data uploaded by March 3</td>
<td></td>
<td>• Understand why the yield stress can be different in tension and compression</td>
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<td>• Describe hardness tests and their limitations</td>
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<td>• Predict the effect of temperature on yield stress</td>
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<td>• Predict the effect of pressure on yield stress</td>
</tr>
<tr>
<td>Feb 25</td>
<td>9. Dislocations HOMEWORK #3 DUE</td>
<td>Text 4.1, 4.2, 4.4</td>
<td>• Calculate the shear stress on a slip system and compare it to the critical shear stress</td>
</tr>
<tr>
<td>March 1</td>
<td>EXAM #1 (Chapters 1-3)</td>
<td></td>
<td>• Describe the slip systems for FCC and BCC</td>
</tr>
<tr>
<td>Lab-Mar 3</td>
<td>Lab #5 Four Point Bending (SHORT REPORT DUE March 24) DATA UPLOADED BY Mar 17</td>
<td>Lab Manual Text 9.6, 8.3, 7.10 Weibull Analysis in text</td>
<td>• Describe why 5 independent slips systems are required for ductility</td>
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<td>• Describe the difference between edge and screw dislocations</td>
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<td>• Determine if the interaction</td>
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<tr>
<td>Mar 4</td>
<td>10. Dislocations SPRING BREAK</td>
<td>Text 4.4</td>
<td></td>
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<tr>
<td>Mar 15</td>
<td>11. Martensite and other Steel Structures Snowdate....12. Dislocations</td>
<td>11.2, 11.4 and handout</td>
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<tr>
<td>Lab-</td>
<td>Lab #6 Jominy End Quench</td>
<td>Lab Manual</td>
<td></td>
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<tr>
<td>Date</td>
<td>Activity</td>
<td>Reading</td>
<td>Notes</td>
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</tbody>
</table>
| Mar 17 | (FULL REPORT Due March 31)                                              | Callister 10.6, 10.7 - handouts | between two dislocations will be favorable  
|        |                                                                          |               | Predict the distance between partial dislocations from the stacking fault energy  
|        |                                                                          |               | Calculate line tension for a curve dislocation  
|        |                                                                          |               | Describe a Lomer-Cotrell Lock  
|        |                                                                          |               | Calculate dislocation energy and stress  
| Mar 18 | 12. Dislocations                                                         | Text 4.4      |                                                                           |
| March 22 | 13. Volumetric Defects  
HOMEWORK #4 DUE                                                                 | Text Chapter 5  
Not 5.4.3, 5.4.4, 5.7, 5.8 | • ASTM Grain size measurement methods  
• Structure of a grain boundary  
• Grain Boundary Energy  
• Effect of grain size on yield stress  
• Dislocation pileup – g.b. as obstacles |
| Lab-Mar 24 | Intro to strengthening team  
experiments Read and Plan processing  
Precipitation Kinetics Reviewed                           | (Draft Plan due to Mr. VanSteel due Mar 29 for what processing you will be doing) | |
| March 25 | 14. Work Hardening                                                      | Text Chapter 6  
NOT 6.3.2, 6.4 | • Suggest several ways to strengthen a metal or metal alloy  
• Describe the mechanisms behind work hardening in single crystals  
• Predict the increase in yield stress due to solutes and precipitates,  
• Predict the effect of grain size on hardening (strengthening) |
| March 29 | 15. Strengthening in Metals                                             | Text Chap 10  
NOT 10.3.4-10.3.6, 10.6, 10.7 |                                                                           |
| Lab-Mar 31 | Strengthening - Team Experiments  
Modify Materials                                                      | Lab Manual + books | Draft plan to Dr. S. describing your hypothesis of how your processing will affect microstructure and therefore properties |
| Apr 1   | 16. Fracture – Macroscopic                                              | Text Chapter 7.1-7.6 | • Differentiate ductile and brittle fracture surfaces  
• Calculate the stress |
<table>
<thead>
<tr>
<th>Lab-Apr 7</th>
<th>Lab #7 Fracture Toughness Charpy Impact Test (SHORT REPORT Due April 21) Data uploaded April 14</th>
<th>concentration at a crack tip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apr 8</td>
<td>18. Fracture - Microscopic HOMEWORK #5 DUE</td>
<td>• Describe the logic behind the Griffith Criteria</td>
</tr>
<tr>
<td>Apr 12</td>
<td>EXAM #2 (Chapters 4-7)</td>
<td>• Be able to apply failure criteria to predict failure</td>
</tr>
<tr>
<td>Lab-Apr 14</td>
<td>NO SCHEDULED LAB BECAUSE NO CLASSES – BUT YOU ARE WELCOME TO COME IN</td>
<td>• Be able to describe several toughening mechanisms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Describe fracture toughness testing methods and calculate fracture toughness from data</td>
</tr>
<tr>
<td>April 19</td>
<td>20. Creep Polymers</td>
<td>Text 13.11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Describe the three stages of creep</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Predict steady state creep using Nabarro-Herring and Coble Creep laws</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Calculate activation energy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Use the Larson-Miller parameter and data to predict remaining lifetime.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Apply Time-Temp-Superposition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Molecular and atomic mechanisms of creep</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Deformation Maps</td>
</tr>
<tr>
<td>Lab-Apr 21</td>
<td>Strengthening - Team Experiments Modify Materials / Test Materials</td>
<td>Lab Manual</td>
</tr>
<tr>
<td>April 22</td>
<td>21. Fatigue</td>
<td>Text Chapter 14.1-14.8</td>
</tr>
<tr>
<td>Apr 26</td>
<td>22. Fatigue HOMEWORK #6 DUE</td>
<td>Text Chapter 14.1-14.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Read an S-N curve</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Use the Palmer-Mindquist relationship</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Predict lifetime using Paris Law or Coffin Law</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Apply Goodman Diagrams</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Be able to characterize fracture surfaces</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Describe methods used to improve fatigue resistance</td>
</tr>
<tr>
<td>Date</td>
<td>Event</td>
<td>Source</td>
</tr>
<tr>
<td>-----------</td>
<td>----------------------------------------------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>April 29</td>
<td>23. Composites</td>
<td>Text Chapter 15.1-15.6 NOT 15.5.4, 15.5.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>May 3</td>
<td>EXAM #3 (Chapters 9-14)</td>
<td></td>
</tr>
<tr>
<td>May 5</td>
<td>Strengthening - Team Experiments</td>
<td>Lab Manual</td>
</tr>
<tr>
<td>May 6</td>
<td>Final Laboratory Presentations</td>
<td></td>
</tr>
<tr>
<td>May 10</td>
<td>Final Laboratory Presentations</td>
<td></td>
</tr>
</tbody>
</table>

Overall Course Outcomes

1. Students should have a basic understanding of several mechanical properties tests and the use of ASTM standards to complete valid tests.

2. Students should be able to use quantitative equations to describe observed mechanical behavior of materials (such as hardening laws) and predict failure (Von Mises Criteria, Paris Law)

3. Students should have a basic understanding of the relationship between atomic, and microscale structure and mechanical properties.

4. Students should have a basic understanding of strengthening mechanisms in metals and the role of dislocation motion and structure as a result of strengthening processing.

5. Students should have a basic understanding time and temperature dependent behavior in all materials with an emphasis on polymers.

6. Students should have a basic understanding of stress tensors and transformation of stress.
Tech 025: Industrial Materials Technology  
Fall, 2008 Edition, Dr. Seth P. Bates, Professor

Industrial Materials is a class required for all students in the Manufacturing Systems program in the Department of Aviation & Technology and also serves students in Industrial Design and Aviation programs. In this course you will learn about the structure of materials from the inside out, and how that structure affects the properties of materials. You will conduct tests to explore these properties in the laboratory, and conduct some study of materials that interest you in a research paper. The course covers materials science principles, metallurgy (ferrous and non-ferrous), ceramics, semiconductors, polymers, and composites.

The faculty of the Department of Aviation and Technology thank the faculty of the Department of Chemical and Materials Engineering for the use of many course elements, beginning in Fall of 2004.

To read some of the documents referred to in this page, you will need the Adobe Acrobat Reader. Click the link to get it! Be sure to press the “Reload” button regularly in order to see the site updates!

Check writing guidelines posted to Course Documents pages, including instructions for turnitin.com. Browse to turnitin.com

Current  
Readings  
See Course Reading Schedule (below)

For Lab  
Be there and be prepared. See Lab Schedule (below)

Download images from Metallurgy Lab here

See also the excellent resources available at Dr. Gleixner’s MatE 25 Learning Center: http://www.engr.sjsu.edu/sgleixner/mate25/

### Primary Course Documents:

- **Course syllabus:** describes course purposes, requirements, and grading.
- **Course Reading Schedule:** lists readings by week
- Lab Syllabus and outline: lists the readings, assignments, and calendar for the course. Lab Greensheet and Schedule
- Course Learning Objectives list
- Format for Homework Assignments

### Laboratory Documents

Lab Experiments: information about laboratory exercises. Please note that not all of these have been adapted to our uses, and we will not cover all of them in any given semester.

- **LN-0** - Cover Page for Lab Notes
- **Table of Contents and Preface** (includes lab writing guide)
- **LN-1** - Introduction to Materials
- **LN-2** - Corrosion
- **LN-3** - Crystal Structures/Rules for planes & directions
- **LN-4** - Crystal Defects
- **LN-5** - Magnetic Properties of Materials
- **LN-6** - Cold Working of Brass
- **LN-7** - Electrical Resistance of Metals
- **LN-8** - Resistance in Semiconductors
- **LN-9** - Tensile Test and Glass Fracture
- **LN-10** - Integrated Circuit Lab
- **LN-11** - Polymers
- **LN-11** - Polymer Data Sheet only
- **LN-12** - Lead/Tin (Pb/Sn) Phase Equilibrium Diagram
- **LN-13** - Tempering of Steel

### Course Resources:

### Lecture Notes and Powerpoints

Chemistry Review and other Links:
- Lee Buescher’s Atomic Time Line
- City College of New York Atomic Structure Page
- Web Elements Periodic Table
- SJSU’s World of Materials
- Univ of Illinois Intro to Materials Engineering

- **Iron-Carbon PED**
- Powder Metallurgy images
- Electromotive Potential of Metals
- Tensile Test Problem
- AIST Steels Nomenclature
- Learning about ASTM
- Lever Rule and the PED
- Silicon Wafer Processing overview
- Glossary of Terms for Plastics
- Polymer and Composites Lecture outline
- Polymer Additives and Reinforcements

**Dr. Stacy Gleixner’s World of Materials**

**Dr. Gleixner’s web links page**

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<table>
<thead>
<tr>
<th>Course Reader</th>
<th>Internet Links</th>
</tr>
</thead>
<tbody>
<tr>
<td>(old version, under revision. check new labs above)</td>
<td>Vision Engineering Web Pages</td>
</tr>
<tr>
<td>Course Term Project Guidelines</td>
<td>MatWeb Materials Property Data</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Secondary Course Documents:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universal Course Documents page! This is where you will find MANY things you need for this course.</td>
</tr>
<tr>
<td>Materials Selection Process and Report guidelines</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Resources:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universal Course Documents: these documents apply to all courses</td>
</tr>
<tr>
<td>APA Manual of Style Crib Sheet</td>
</tr>
</tbody>
</table>

| Internet Resources - weblinks page | What is happening in this image? |

Seth Bates' [Home Page](#)

This web page is under the supervision of Dr. Seth Bates. He can be reached at sbates@cisu.edu or by phone at (408) 924-3227.
Course Syllabus for Fall, 2008
Materials Technology

Office Hrs: MW 0900-1100, TR 1300-1400
Sections & Rooms: 025-01, T 3:00-4:45 (IS 132), 025-11 R 3:00-5:45 (E105)
Office Room: Industrial Studies Building, Room 111
Office Phone: (408) 924-3227
FAX: (408) 924-3198
Email: sbates@sjus.edu
Web: www.engr.sjsu.edu/sbates
Department phone: (408) 924-3190

Purpose
This is an introductory course designed to familiarize the student with materials, their properties and testing, and their processing as used in design and production by industry. The course will cover material characteristics, treatments and preparations, forming, processing, and inspections required for use in construction and maintenance by product manufacturers and aircraft and aerospace companies.

Prerequisites
All Aviation and Technology majors must have completed Chem. 1A and Phys 2A, or be taking this at the same time as this course. Students from Industrial Design or other majors should discuss their chemistry and physics background with the instructor. Students who do not meet prerequisites must drop the course or lose credit for work performed class. Students must own and be able to use a pocket calculator. Basic computing skills in word processing and spreadsheet work are advisable and encouraged. (Format: Lect. 2 hours, 2 units, Lab. 3 hours, 1 unit.) There will be two hours of lecture and one laboratory period per week.

Course Description
Study of industrial materials and their applications including metals, polymers, and composite materials. Selection principles. Laboratory experimentation, testing and evaluation procedures. Prerequisite: Chem 1A and Phys 2A (or equivalent). Misc/Lab: Lecture 2 hours/lab 3 hours. 3 Units.

General Course Objectives
All students who participate in Tech025 should come away with
(1) Knowledge of how materials have shaped the history of the world including current technologies.
(2) A recognition of the necessity of materials selection in each engineering/technology discipline and an understanding of some ways that material properties determine performance in applications.
(3) A recognition of the practice of materials engineering and materials testing, and an identification of some ways that material process choices influence structure, properties, and processability.
(4) An identification of various types of materials that would be appropriate for use in biomedical, communication, electronics, transportation, recreation, construction, and other applications.

Lab Fees: $25.00. The fee is incorporated into your registration process.

Required Texts
Tech 25 Laboratory Handbook: Modules available as needed through the class website. Print these and read and mark them thoroughly BEFORE each corresponding lab period. Bring your marked copy to lab with your lab book. The reading schedule is provided in the document Tech025_Readings_F08.doc on the web site.
Course Website and Communications

The course Website can be accessed from Dr. Bates’ homepage: http://www.engr.sjsu.edu/sbates

When you find the Tech025 Website, open it in its own window, then set a bookmark to get back to it easily. Check the Tech025 Website frequently for homework, exam solutions, and course updates. The site also has links to interesting sites where you can learn more about materials engineering.

This course uses email for correspondence. You must have and regularly use an email account which can send and receive documents in Microsoft Word format. Send your instructor an email during the FIRST week of class which contains the following information on the subject line:

    Subject: tech025, your name, subject (e.g., 'greeting')

Include your name, mailing address, phone numbers, and email address in the body of the email. I will reply to you in order to verify that we each have the correct email. Your email will be added to a class email list, which will be used to communicate with the class — to clarify material covered in lecture, hints and changes on the homework, or other class information. Keep your email active and check it regularly, or you may miss important information. DO NOT Zip files, and do not send files only in pdf or Word formats.

Class and Lab Times and Activities

Your ACTIVE participation in both the lecture and laboratory sessions is required. You will be expected to ask questions, answer questions, and work together with your peers to solve problems during class time. The reading assignments for each week are listed on the Lecture Schedule (available on the web site). You are expected to complete the week’s reading before class and before attending the lab section. There will be quizzes on the readings! Bring your textbook and a calculator to lecture and lab - collaborative group learning activities will take place during classes. Please turn off cell phones during both lecture and lab!

Academic Integrity - http://www.sjsu.edu/senate/F06-1.htm

Your own commitment to learning, as evidenced by your enrollment at San Jose State University, and the university’s Academic Integrity Policy requires you to be honest in all your academic course work. Faculty members are required to report all infractions to the office of Student Conduct and Ethical Development. The policy on academic integrity can be found at http://sa.sjsu.edu/student_conduct.

Strict standards of academic honesty will be enforced in this class. Students who plagiarize any portion of their lab reports will receive an F (0) on that report with no chance of make-up and will also be reported to the University. Plagiarism constitutes copying any portion of your lab from textbooks, lab notes, previous years’ lab reports, or the reports of other students. Verbatim copying from web sites is also plagiarism. We will discuss correct ways to use and cite references in class.

Any figures used from textbooks or the Lab Notes must be properly credited. Homework assignments that you turn in must have been worked out entirely by you. You can study with friends and work out the problems together, but you must then independently work it through and record your own work. Students who provide their homework or labs to other students so that they can be copied are also committing a breach of academic honesty. If you wish to help other students learn the material, studying together is acceptable as long as each individual goes on to produce their own independent work.

Students with Disabilities

Campus policy in compliance with the Americans with Disabilities Act:

http://www.sjsu.edu/president/docs/directives/PD_97-03.pdf
If you need course adaptations or accommodations because of a disability, or if you need special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible, or see me during office hours. Presidential Directive 97-03 requires that students with disabilities requesting accommodations must register with DRC to establish a record of their disability.

**Laboratory Activities**

Some weeks the lab sessions will be devoted to experiments; other sessions will be devoted to tutorials, workshops, demonstrations or other activities. Laboratory activities are an integral part of this course, and attendance is required. Unexcused absences in lab will result in a zero for any assignments related to that lab as well as your overall lab grade being reduced 10% for every lab missed unexcused. Laboratory quizzes will be averaged into the overall laboratory grade along with lab reports and other activities. There will generally be a quiz at the beginning of each lab period, covering the previous week’s lab material and/or the reading assignment. There will also normally be an exit quiz each week, which will demonstrate your mastery of the material covered in the lab that day. You can prepare for the quizzes by reviewing what we did in lab the previous week, by doing the appropriate data analysis on your experimental data from the previous week, and by being fully prepared for each lab before you arrive at lab. The appropriate reading assignment for each lab is listed in the Schedule (below).

Laboratory work requires the use of safety glasses, which you must purchase. See the lab safety guide for information on lab safety. Section lab grades may be scaled up or down to account for discrepancies in grading between lab instructors.

**Laboratory Reports**

Laboratory reports are due one (1) week after the laboratory unless otherwise specified. Only reports that are prepared on a word processor will be accepted. Lab reports will be accepted late, with a letter grade deduction per day late (lab reports more than 5 days late will not be graded). Late lab reports must be time stamped at the department office (IS 111) and left for the instructor.

The course instructor will inform you of specific report requirements. Consult guidelines on the web site for a list of the sections required in the lab reports. Lab reports must be turned in to turnitin.com as well as to your instructor. Directions for turnitin.com will be given in lab. Reports not turned in to turnitin.com will be given a zero grade.

**Homework Assignments and Quizzes**

Homework must be submitted on the due date at the start of class period. No late assignments will be accepted. There may be unannounced quizzes given only at the beginning of class, and assignments are late if turned in after these quizzes begin. If you arrive late to class to turn in a paper, your paper will be marked late. Exceptions will be made to this policy only in critical situations, which must be documented by you. Please call or email your instructor as soon as possible to take care of such documentation. If you cannot be present on the day an assignment is due, you should arrange to do one of the following.

- Arrange to have the assignment delivered at the beginning of class,
- mail the assignment to your instructor at the university (It must be post-marked by the due date).
- Email the assignment to your instructor (your email system will date and time stamp the transmission before the due date indicated in the assignment).

Your name and section number must be listed in the upper right hand corner of the assignment. You are encouraged to work together on the assignments; however, you must turn in individual homework solutions. You are required to list the names of the students you worked with below your name in the upper right hand corner of your packet. Groups can be no larger than 3 students. If similar solutions are passed in by multiple
students but they do not state they worked together, all the students with similar solutions will receive a ‘0’ on that assignment.

You must have actively participated in solving everything you pass in and have a full understanding of the solution you submitted. Copying partial or complete answers from other students is unacceptable. You will receive a 0 on the assignment and be reported to the University if you copy any portion of the homework or if you allow your homework to be copied.

Test questions will target material learned through the homework, readings, and lab exercises. If you do not fully understand the solutions you pass in, you not only risk getting a 0 on that assignment but you will not be able to answer the related questions during the tests. This will significantly affect your overall grade!
Come to office hours if you are having trouble doing the homework yourself.

Examinations
There will be one midterm examination and one final examination. Examinations will cover material from lectures and labs as well as homework problems. Use the learning objectives as a guide for studying. The dates of each examination are indicated in the Lecture Schedule. These dates may be changed depending on the progress of the lecture. Seating assignments may be given out for exams. Absence during examinations, without prior approval, will result in a zero. Prior approval will be given only under exceptional circumstances.

Withdrawing / Changing Sections
Please be aware of the University Withdrawal schedule. It is your responsibility to drop or add classes. Pay particular attention to the ‘Last day to drop for refund of fees and without a "W"’ and the ‘Add Deadline’. Withdrawals after the drop deadline are granted only for “serious and compelling reasons”; this usually refers to extreme personal or family problems, which must be documented. Registering for too many units is not considered a serious and compelling reason to drop a class. Note that if you fail the course and attempt to take it the following semester under Academic Renewal, you will have last chance for adding the class. If you stop coming to class without filing a withdrawal, or do not take examinations, you will receive a grade of “U” which reverts to an F on your transcript.

Grading

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
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</thead>
<tbody>
<tr>
<td>Mid-term</td>
<td>20%</td>
</tr>
<tr>
<td>Final examination</td>
<td>20%</td>
</tr>
<tr>
<td>Homework</td>
<td>10%</td>
</tr>
<tr>
<td>In-Class Quizzes &amp; Activities</td>
<td>10%</td>
</tr>
<tr>
<td>Lab</td>
<td>40%</td>
</tr>
<tr>
<td>Lab reports &amp; Oral Quiz</td>
<td>70%</td>
</tr>
<tr>
<td>Lab participation and neatness</td>
<td>10%</td>
</tr>
<tr>
<td>(Worksheets and lab quizzes)</td>
<td>20%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
</tbody>
</table>

A+ 97 – 100   A 94 – 96   A- 90 - 93
B+ 87 – 89   B 84 – 86   B- 80 – 83
C+ 77 – 79   C 74 – 76   C- 70 – 73
D 60 – 69   F < 60

The final course and laboratory grades may be normalized to a standard curve.

Final Exam: See online exam schedule at http://info.sjsu.edu/web-dbgen/narr/soc-fall/rec-232.html

Tech 025   Industrial Materials Syllabus
Learning to use ASTM Standards, Specifications, and Definitions

Website:  www.astm.org

About ASTM International
Organized in 1898, ASTM International is one of the largest voluntary standards development organizations in the world. ASTM International is a not-for-profit organization that provides a forum for the development and publication of voluntary consensus standards for materials, products, systems, and services. More than 20,000 members representing producers, users, ultimate consumers, and representatives of government and academia develop documents that serve as a basis for manufacturing, procurement, and regulatory activities.

Why we use ASTM Standards
ASTM is the primary source for standards methods of testing, definitions, and specifications in the United States. Internationally, ISO and DIN standards may be more well known. Find the web sites for a number of standards organizations and collect them in a section of your assignment.

Assignment

Locate the ASTM Standards volumes in the MLK, Jr. Library. They are stored in two sections: Stacks, and Technical Reference. Find them both. If you decide to check out a volume from stacks, please return it to the library as soon as possible so others can use it!

1. Locate the first volume of the set. This should be a comprehensive index for the set. Look at it and see how it is organized (two ways).

2. Describe the two sections of the index in your homework.

3. Select a volume of the Standards at random or according to your personal interests. Within the volume, look for three different kinds of entries:
   - Standard Method of Test for ...
   - Definitions of Terms relating to ...
   - Specifications for ...

   If you cannot find an example of each of these, look in another volume or use the index. Each of these kinds of entries serves a different kind of purpose. For each standard that you find, do the following:
   
   - List the full number and title of the entry.
   - In your own words, summarize the purpose of the method or standard
   - In your own words, indicate the kinds of material(s) that the standard relates to, and what specific kinds of specimens are used in the standard, if any.
   - Why would the standard be of value to you, or not.

Prepare your report in a word processor, using the standard report format from the website. Do this succinctly (look it up). Keep your complete assignment to one page if possible, no more than 1 ½ pages maximum. Submit the report in hard copy on the date specified in the topic outline. See the course syllabus and topic outline for information on due dates and late reports.
The University of Mississippi  
Department of Mechanical Engineering

ME 538  
EXPERIMENTAL CHARACTERIZATION OF POLYMER COMPOSITES  
Methods for the experimental characterization of polymeric composites. Topics  
include testing standards, test methods, and data analysis procedures.

Prerequisites:

ENGR 313  
INTRODUCTION TO MATERIALS SCIENCE  
Fundamental concepts of materials science including the structure and properties  
of materials and their relationship to material selection and system design. The  
internal structures of metals, ceramics, and polymers are examined to develop  
an understanding of their mechanical, electrical, physical, and chemical  
properties.

ENGR 314  
MATERIALS SCIENCE LABORATORY  
Laboratory investigation of crystal structure, defects, and diffraction theory;  
solidification of solids; microstructurally controlled physical and mechanical  
properties.

This Overview and Syllabus is posted with permission and provided for educational  
purposes only. Any use of this material shall include attribution to its author, Ellen  
Lackey, Ph.D, University of Mississippi, University, MS
ME 538 – Experimental Characterization of Polymeric Composites
Spring 2010


ASTM standards student campus package from http://www.astm.org/campustandards.html (details concerning instructions to access the standards package will be provided to you in class)

Current literature related to characterization of polymeric composites


Statistical Software:
Stat17, the software recommended for performing statistical analysis in conjunction with the MIL-HDBK-17 procedures will be used in the course. These procedures are described in detail in Vol. 1, Chapter 8 of the handbook. The Stat17 Excel macro program will be provided to you.

Instructor/Contact
Information: Dr. Ellen Lackey, Associate Professor, Mechanical Engineering
Office: 201 G Carrier Hall, Hours: TBA
email: melackey@olemiss.edu

Course Description:
This course will introduce students to the field of polymeric composites, the numerous techniques available for experimental characterization of polymeric composites, and the processes and procedures associated with the standardization procedures followed in the industry. This will be accomplished through lectures, discussions, demonstrations, projects, and quizzes. Through this course, students will examine both the theoretical and practical aspects of experimental characterization of composites. Students will gain experience in the use of these characterization techniques through hands-on projects. Safety precautions related to fabrication and testing of composites will also be emphasized.
Course Objectives: Students will apply knowledge of mathematics, science, and engineering to as they identify, discuss, and review information related to the area of experimental characterization of polymeric composites.

Students will apply course topics to select, design, and conduct and evaluate appropriate testing methods and procedures to provide required data for polymeric composites. Students will also analyze data obtained from the test methods. These projects will require the hands-on use of modern engineering tools to acquire the required data. Students will also utilize their abilities to identify, formulate, and solve engineering problems in the context of these projects.

Students will identify, present, and discuss and evaluate contemporary issues related to the area of experimental characterization of polymeric composites through the examination of current research literature.

Students will recognize and develop an understanding of professional and ethical responsibility through the application of the Engineering School Honor Code to class assignments.

Students will practice effective communication through the preparation of written reports and the presentation of oral reports. Modern tools including computers, presentation software, and state-of-the-art presentation tools will be employed for all reports.

Class Grade:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test 1</td>
<td>20%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>20%</td>
</tr>
<tr>
<td>Quizzes</td>
<td>20%</td>
</tr>
<tr>
<td>Projects</td>
<td>25%</td>
</tr>
<tr>
<td>Participation/Assignments</td>
<td>15%</td>
</tr>
</tbody>
</table>

Graduate students will have additional requirements on tests, assignments, and projects.

Project:
A testing project making use of the characterization techniques discussed and demonstrated in class will be assigned during the course. The project will be conducted in teams, and students will be expected to draw on class lecture material to design and implement the appropriate test techniques necessary to obtain the desired material property data. Students will work in teams to conduct the necessary laboratory tests and analyze their data. In addition, graduate students will produce a report of their findings in the form of a research paper suitable for publication. Students will not be allowed to use test equipment which will be necessary for completion of the project until they have demonstrated sufficient understanding of the safe operation of the equipment.
Honor Code:
In all classes, engineering students are expected to uphold the standards expected in the engineering profession. All tests, quizzes, projects, assignments, and homework are to be completed in accordance with the School of Engineering Honor Code. As such, a student may not give or receive any assistance on any of these unless specifically noted. Students may have general discussions concerning homework sets, but, because homework is a graded component of the course, students must independently work to solve the homework problems. A complete copy of the Honor Code may be obtained from the School of Engineering Honor Council or over the WWW at

http://www.olemiss.edu/depts/engineering_school/students/current/honor_council.html

Class Preparation:
Each student should read all assigned material prior to the scheduled class meeting and be prepared to ask questions and/or discuss the material covered in the class lecture.

Topics to be covered in class are shown below. Students are expected to read the relevant textbook material for each topic prior to the class meetings. In addition to the Mil-17 pages listed, appropriate ASTM (or other) standards and relevant pages in the provided course pdf files should also be read as assigned. Topics to be read for the upcoming class will be announced prior to that class period.

General Composites Introduction
Composites Manufacturing Methods
Composite Constituent Materials
Quality Assurance Methods for Composites
Introduction to Mil-17 (CMH-17)
Standards Development Procedures
Webinar by ASTM D30 Committee
Application of Testing to Building Block Approach to
  Composite Design and Test Methods (Mil-17 Vol. 1 - Ch. 2, pp. 2-1 - 2-10)
  Statistical Data Analysis (Mil-17 Vol. 1 - Ch. 8)
Sample Prep, Conditioning, and Testing Equipment (Mil-17 Vol. 1 - Ch. 6, pp. 6-1 - 6-27)
  Tensile Testing (Mil-17 Vol. 1 - Ch. 6, pp. 6-89 - 6-102)
  Compression Testing (Mil-17 Vol. 1 - Ch. 6, pp. 6-104 - 6-115)
  Shear Testing (Mil-17 Vol. 1 - Ch. 6, pp. 6-116 - 6-127)
  Flex Testing (Mil-17 Vol. 1 - Ch. 6, pp. 6-128)
Volume Fraction Determination (Mil-17 Vol. 1 - Ch. 6, pp. 6-42 - 6-50)
Fracture Toughness Testing/Delamination Characterization (Mil-17 Vol. 1 - Ch.
  6, pp. 6-128 - 6-137)
DSC/Rheology (Mil-17 Vol. 1 - Ch. 6, pp. 6-13 - 6-19)
Flammability and Smoke Generation Testing (Mil-17 Vol. 1 - Ch. 6, pp. 6-78 - 6-87)
Electrical Property Testing (Mil-17 Vol. 1 - Ch. 6, pp. 6-87 - 6-88)
Structural Element Characterization (Mil-17 Vol. 1, Ch. 7)
Other test methods
Instructors:
Prof. Stephanie Walkup
Office: Room 269 Kirkbride Hall
Phone: 610-787-0225
Email: slwalkup@mail.widener.edu

Prof. Vicki L. Brown
Office: Room 349 Kirkbride Hall
Phone: 610-499-4607
Email: vlbrown@mail.widener.edu

Required Texts:

*CE 306 Lab Manual*, Widener University Civil Engineering Department, Spring 2009. (Available through the shared files on the Campus Cruiser course web page or purchased in the CE office).

Co-requisites: ENGR 323 Mechanics of Deformable Bodies

Course Purpose:
CE 306 is a writing enriched course that provides students an opportunity to conduct laboratories and participate in a group design-build-test project in Civil Engineering topics including engineering mechanics, construction materials, and structures. The labs and projects give students hands-on experiments that demonstrate theoretical topics covered in previous/concurrent engineering courses and provide an introduction to topics that will be covered in future courses.

The laboratories emphasize measurement techniques, analysis and interpretation of data, and technical writing in the form of lab reports. The design-build-test project gives students an opportunity to work in teams, and present their work in an oral presentation and group report.

Course Objectives:
The Structures and Materials Laboratory is intended to (1) supplement theoretical knowledge in CE structures and construction materials; (2) provide exposure to basic measurement and experimental techniques to examine properties of materials and structural components; (3) develop the ability for planning and design of projects; (4) familiarize the student with basic statistics for analysis of experimental data; (5) develop written and oral communication skills; and (6) provide exposure to the interpersonal relationships involved in group work.

Upon successful completion of the course, students will be able to:
1. Conduct experiments to measure properties of materials and systems for civil engineering applications.
2. Analyze data for error analyses, comparison of experimental and theoretical results, application of regression analyses.
3. Prepare engineering laboratory reports using appropriate technical writing methods.
4. Design, conduct, and present an independent project.

Program Outcomes: This course supports the following CE Program Outcomes:
2. An ability to apply the fundamental knowledge of mathematics, science, & engineering, as well as the ability to use the techniques, skills, and modern engineering tools to solve civil engineering problems in practice.
4. The ability to design a civil engineering system, component, or process to meet the requirements of safety, cost, quality, and performance.
5. An ability to conduct laboratory experiments, and to analyze and interpret data in various civil engineering disciplines.
6. An ability to communicate effectively and function well on multidisciplinary teams.

Grading: The +/- system will be used for course grades.

Labs and Lab Reports: 75% of the course grade will be based on participation in laboratory experiments and preparation of lab reports (both writing and editing). A total of 7 labs are planned. Lab reports are due **one week** after the completion of the lab. Lab reports handed in **after the due date but not more than one week late** will receive a maximum score of 80%. **LAB REPORTS WILL NOT BE ACCEPTED MORE THAN ONE WEEK AFTER THE DUE DATE. A LAB REPORT MUST BE HANDED IN TO RECEIVE A NON-ZERO GRADE FOR THE LAB.**

Two lab reports will be edited by the instructors and handed back to students to revise and resubmit so that students can learn to edit and improve their technical writing. The first lab report submitted must be revised and resubmitted by every student. The second lab report to be revised and resubmitted is student choice (it would be wise to revise a report you do poorly on, to improve your grade, as the final grade for the lab will be based on the resubmitted lab report). **The original report MUST be handed in with the revised and resubmitted lab report in order to receive full credit for the lab.**

Your performance and preparation for the lab will be assessed as part of the lab grade. You are expected to be familiar with the objectives and lab procedures prior to the lab, and you may be asked to write them prior to the start of the lab. Unannounced quizzes may be given prior to the lab to assess your preparation. Lab procedures will be discussed in the lecture period prior to the lab, with any changes or deviations from the lab manual explained by the instructor.

**Design-Build-Test Project:** 25% of the course grade will be based on the design, conduct, and presentation (oral presentation and written group project report) of a group design-build-test (DBT) project. This year we will be using the 2009 EDPACI Concrete Beam student competition for the DBT project.

**Attendance:**
Attendance and participation is required in order to receive a grade for each lab, unless prior notification and arrangements are made with the instructor. All unforeseen emergencies will be dealt with on a case by case basis. **Instructors will NOT routinely excuse students from lab.** Documentation of ANY planned or emergency absence will be required.
## CE 306A Structures and Materials Laboratory Course Schedule – Spring 2009

Note: Schedule Subject to Change if Necessary

ALL LABS IN STRUCTURES LAB AT WELLNESS CENTER UNLESS NOTED OTHERWISE

<table>
<thead>
<tr>
<th>Week</th>
<th>Wednesday Lecture Date/Topic</th>
<th>Tuesday Lab Date/Topic</th>
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| 1    | Jan. 14: Course Expectations/Professional Communication  
  *Technical Writing Assignment Due* |
| 2    | Jan. 21: Experimental Statistics | Jan. 20: Lab #2A Concrete Mix Design in KH 235  
  *Concrete Lab #2A (Introduction/Methods & Procedures)* |
| 3    | Jan. 28: Design-Build-Test Project | Jan. 27: Lab #3 Uniaxial Tension Tests  
  *Tension Tests Lab #3 Due* |
| 4    | Feb. 4: Truss Lab Calculations | Feb. 3: DBT Project – Design in KH 235  
  *DBT Project Proposal Due/Concrete Lab #2A* |
| 5    | Feb. 11: Professional Document Design  
  *Chapter 2 in Textbook* | Feb. 10: Lab #4 Trusses/Hooke’s Law  
  *Truss Lab #4 Due* |
| 6    | Feb. 18: Basic Grammar & Sentences  
  *Chapters 3 & 4 in Textbook* | Feb. 17: Lab #2B Concrete Testing  
  *Concrete Lab #2 (including revisions) Due* |
| 7    | Feb. 25: Punctuation, Spelling & Mechanics  
  *Chapters 5 & 9 in Textbook* | Feb. 24: DBT Project - Build  
  *Concrete Lab #2 (including revisions) Due* |
| 8    | Mar. 11: DBT Predictions Calculations | Mar. 10: Lab #5 Asphalt Testing |

**SPRING BREAK**

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<table>
<thead>
<tr>
<th>Week</th>
<th>Wednesday Lecture Date/Topic</th>
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| 9    | Mar. 18: Sentence Structure, Style & Usage  
  *Chapters 6 & 7 in Textbook*                                                          |
| 10   | Mar. 25: Peer Editing  
  *Sections 1.4 & 1.5 in Textbook*                                                       |
| 11   | Apr. 1: Wooden Beam Calculations                                                           |
| 12   | Apr. 8: Photoelastic Beam Calculations                                                      |
| 13   | Apr. 15: Oral Presentations  
  *Section 13.6 in Textbook*                                                                |
| 14   | Apr. 22: Guest Lecture *Engineering Standards*                                             |
| 15   | Apr. 29: Presentation Evaluations                                                          |

<table>
<thead>
<tr>
<th>Tuesday Lab Date/Topic</th>
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| Mar. 17: Field Trip – Testing Lab  
  *Asphalt Lab #5 Due* |
| Mar. 24: DBT Project – Testing  
  *DBT Predictions Due at Start of Lab* |
| Mar. 31: Lab #6 Wooden Beams |
| Apr. 7: Lab #7 Photoelastic Beam  
  *Wooden Beam Lab #6 Due* |
| Apr. 14: Field Trip – Construction Site  
  *Photoelastic Beam Lab #7 Due* |
| Apr. 21: DBT Project Presentations in *KH 235*  
  *DBT Project Report Due* |
| Apr. 28: No Lab  
  *Second Revised Lab Report Due* |