THE UNIVERSITY OF TEXAS AT AUSTIN
Department of Aerospace Engineering and Engineering Mechanics

EM 319 MECHANICS OF SOLIDS
FALL 2011 SYLLABUS

Unique Numbers: 14165, 14170, 14175, 14180

Instructor: Nanshu Lu, nanshulu@mail.utexas.edu, WRW 305C, 471-4208

Time: Tuesday and Thursday 8:00am – 9:30am

Location: WRW 102

Teaching Assistants: Rong Jiao jiaorong@mail.utexas.edu
John Mersch jmersch@utexas.edu
Andrew Barnes barnesandrew@mail.utexas.edu

Web Page: Blackboard (syllabus, lecture notes, homework, solutions, etc.)

Catalog Description:
Internal forces and deformations in solids; stress and strain in elastic and plastic solids; application to simple engineering problems. Three lecture hours a week for one semester, with discussion hours if necessary.

Course Objectives:
Learn to perform stress, strain, and deformation analyses of simple structures subjected to tension, compression, torsion, bending and internal pressure. Learn to analyze failure under combined loading.

Prerequisites:
Engineering Mechanics 306, Mathematics 408D or 408M, and Physics 303K with a grade of at least C in each.

Knowledge, Skills, and Abilities Students Should Have Before Entering This Course:
The student should have a good command of the material covered in EM 306 Statics, particularly concepts of equilibrium, free-body diagrams, properties of areas such as centroids and second moments and shear force and bending moment diagrams for beams.

Knowledge, Skills, and Abilities Students Gain from this Course (Learning Outcomes):
Fundamental concepts of solid mechanics, including stress, strain, and displacement; analysis and design of simple structural members subjected to tension, compression, torsion, bending and internal pressure; elementary models of material deformation and failure behavior.

Impact on Subsequent Courses in Curriculum:
The course is an essential prerequisite for more advanced mechanics courses such as EM 339, ASE 221K, ASE 324L, CE 329, and ME 336, and ME 338.

**Relationship of Course to Program Outcomes:**
This course contributes to the following ABET Criterion 3 outcomes and those specific to the EAC accredited program.

### AEROSPACE ENGINEERING PROGRAM OUTCOMES

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. An ability to apply knowledge of mathematics, science, and engineering.</td>
<td>g. An ability to communicate effectively.</td>
</tr>
<tr>
<td>b. An ability to design and conduct experiments, as well as to analyze and interpret data.</td>
<td>h. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.</td>
</tr>
<tr>
<td>c. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.</td>
<td>i. Recognition of the need for and an ability to engage in life-long learning.</td>
</tr>
<tr>
<td>d. An ability to function on multidisciplinary teams.</td>
<td>j. Knowledge of contemporary issues.</td>
</tr>
<tr>
<td>e. An ability to identify, formulate, and solve engineering problems.</td>
<td>k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.</td>
</tr>
<tr>
<td>f. An understanding of professional and ethical responsibility.</td>
<td></td>
</tr>
</tbody>
</table>

### ABET Program Criteria Achieved:
Program criteria are unique to each degree program and are to be compiled from the program criteria given for each degree program and listed in table format below. The faculty should check which of the program criteria are achieved in the course.

### AEROSPACE ENGINEERING PROGRAM CRITERIA

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Criterion</th>
<th>Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Aerodynamics</td>
<td>g. Orbital Mechanics</td>
<td>m. Preliminary/Conceptual Design</td>
</tr>
<tr>
<td>b. Aerospace materials</td>
<td>h. Space Environment</td>
<td>n. Other Design Content</td>
</tr>
<tr>
<td>c. Structures</td>
<td>i. Attitude Determination and Control</td>
<td>o. Professionalism</td>
</tr>
<tr>
<td>e. Flight Mechanics</td>
<td>k. Space Structures</td>
<td>x</td>
</tr>
<tr>
<td>f. Stability and Control</td>
<td>l. Rocket Propulsion</td>
<td></td>
</tr>
</tbody>
</table>

### Textbook:
Find it on Amazon:
Class Topics:
- General concepts of stress, strain, material behavior and some design considerations [Ch. 1]
- Axially loaded members [Ch. 2]
- Torsion of circular bars and thin-walled tubes [Ch. 3]
- Shear force and bending moment diagrams [Ch. 4]
- Stresses in beams [Ch. 5]
- Deflection of beams [Ch. 9]
- Statically indeterminate beams [Ch. 10]
- Analysis of stress and strain [Ch. 7]
- Pressure vessels and combined loadings [Ch. 8]

Class Outline and Schedule:
Aug 25 Introduction (Ch 1)
Aug 30 Normal stress and strain (Ch 1)
Sep 1 Mechanical properties of materials, Hooke’s law, structural analysis and design (Ch 1)
Sep 6 Axially loaded members (Ch 2)
Sep 8 Axially loaded members, non-uniform bars (Ch 2)
Sep 13 Statically indeterminate problems (Ch 2)
Sep 15 Thermal effects, misfit and prestrain (Ch 2)
Sep 20 Stresses on inclined sections (Ch 2)
Sep 22 Torsion, torsion of bars (Ch 3)
Sep 27 Non-uniform torsion and shafts, stress and strain in pure shear (Ch 3)
Sep 29 Statically indeterminate torsion (Ch 3)
Oct 4 Pure shear and thin walled tubes (Ch 3)
Oct 6 Beams: shear force and bending moment diagrams (Ch 4)
Oct 11 Beams: shear force and bending moment diagrams (Ch 4)
Oct 13 Beams: pure bending and non-uniform bending (Ch 5)
Oct 18 Beams: curvature, strain, and stress (Ch 5)
Oct 20 Beams: design for bending stresses (Ch 5)
Oct 25 Beams: shear stresses and beams with flanges (Ch 5)
Oct 27 Deflection of beams (Ch 9)
Nov 1 Beams: deflections by integration (Ch 9)
Nov 3 Beams: deflections by superposition (Ch 9)
Nov 8 Statically indeterminate beams (Ch 10)
Nov 10 Statically indeterminate beams using superposition (Ch 10)
Nov 15 Analysis of stress and strain: plane stress (Ch 7)
Nov 17 Principal stresses and Mohr’s circle (Ch 7)
Nov 22 Hooke’s law for plane stress (Ch 7)
Nov 29 Pressure vessels (Ch 8)
Dec 1 Combined loadings (Ch 8)
Class Format:
Each week there will be two lectures (3 hours total) and one discussion session (2 hours). The instructor formally presents the topic covered in the course, and the discussion sessions will be led by one of the teaching assistants, emphasizing on problem-solving procedures. The time and locations are listed below.

<table>
<thead>
<tr>
<th>Unique Number</th>
<th>Time</th>
<th>TA</th>
<th>Classroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>14165</td>
<td>Tuesday 5:00 – 7:00pm</td>
<td>Rong Jiao</td>
<td>CMA A5.136</td>
</tr>
<tr>
<td>14170</td>
<td>Wednesday 5:00 – 7:00pm</td>
<td>John Mersch</td>
<td>RLM 5.120</td>
</tr>
<tr>
<td>14175</td>
<td>Tuesday 6:00 – 8:00pm</td>
<td>Andrew Barnes</td>
<td>RLM 6.126</td>
</tr>
<tr>
<td>14180</td>
<td>Wednesday 6:00 – 8:00pm</td>
<td>Rong Jiao</td>
<td>RLM 5.126</td>
</tr>
</tbody>
</table>

Discussions
- Discussions are regular classes and they must be treated accordingly.
- You must attend only the discussion session for which you are registered.
- Discussion sessions can be changed only through regular registration processes.
- Discussions are the best place to ask questions about homework problems.
- Every discussion session not on the week of a midterm will have a quiz.

Attendance:
Regular attendance is expected. No electronics allowed.

Design Assignments
There are no design assignments for this course.

Laboratory Assignments
There are no laboratory assignments for this course.

Computer:
There is no required use of any computer hardware or software for this course.

Homework Policy:
- About 5 representative homework problems will be assigned at the end of each session.
- It is your responsibility to do the homework problems regularly.
- Homework will not be collected or graded.
- Some of the homework problems will appear in the weekly quizzes.
- Solving the homework problems and studying for quizzes is the best way to prepare for the midterm and final examinations.

Examination:
- There will be three midterm examinations and one final examination in addition to the weekly quizzes. All of them are closed books and notes.
- Use of calculators is allowed.
• Be prepared to present your student ID before or during the exams.
• No make-up quizzes or exams will be given.
• The two lowest scores on the quizzes (that includes zero for absentia) will be dropped.
• Quizzes will be graded and returned one week later at the beginning of the discussion sessions.
• The final exam will be comprehensive and mandatory and held at the officially scheduled time and location.

Mid-term #1  September 19th, 2011  7:00pm – 10:00 pm  CPE 2.208
Mid-term #2  October 17th, 2011  7:00 pm– 10:00 pm  CPE 2.208
Mid-term #3  November 21th, 2011  7:00 pm– 10:00 pm  CPE 2.208
Final        December 10, 2011   2:00pm-5:00 pm

Grading:
Weekly Quizzes (20% total)
3 Midterm Exams (15% each)
1 Final Exam (35%)

Grading Policy:
A: A cutoff around top 20%
B: A cutoff around top 50%
C: A cutoff around top 80%
D: A cutoff around top 90%

Office Hours:
• Nanshu Lu  Tuesday and Thursday 9:30am-10:30am
  The day before each exam 8:00pm-10:00pm on Skype (ID: nanshulu)
• John Mersch Monday 2pm~4pm  WRW 214
• Rong Jiao  Tuesday 3pm~5pm  WRW 109
• Rong Jiao  Wednesday 3pm~5pm  WRW 109
• Andrew Barnes Friday 12pm~2pm  WRW 214

Important Dates:
August 24th, 2011, Wednesday Classes begin.
August 29th, 2011, Monday Last day of the official add/drop period.
September 9th, 2011, Friday Last day to drop a class for a possible refund.
December 2nd, 2011, Friday Last class day.

Special Notes:
The University of Texas at Austin provides upon request appropriate academic adjustments for qualified students with disabilities. For more information, contact the Office of the Dean of Students at 471-6259, 471-4641 TDD or the Cockrell School of Engineering Director of Students with Disabilities at 471-4321.
EM 319 Course Syllabus, Fall 2011

Evaluation:
- Aperiodic survey at the beginning of some classes to evaluate the course and the instructor.
- The Measurement and Evaluation Center forms for the Cockrell School of Engineering will be used during the last week of class to evaluate the course and the instructor.

Prepared by: Nanshu Lu

Last Modified: Aug 30, 2011