1/19/2016

SYRACUSE UNIVERSITY
COLLEGE OF ENGINEERING AND COMPUTER SCIENCE

MECHANICS OF SOLIDS
ECS325 (4 Credits)
Spring 2016

CLASSROOM: HL 214 M, Link 369 T/TH, Link 011 Recitations

CATALOG DESCRIPTION
Theory of deformation, stress, stress resultants, transformation. Elastic and inelastic constitutive behavior. Equilibrium. Tension and torsion of bars; flexure and shear of beams; pressure vessels. Thermoelasticity. Elastic and inelastic stability. Energy methods.

INSTRUCTOR INFORMATION
Prof. Joan V. Dannenhoffer
137 Link Hall
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443-4230
Office Hours: T 12:30 - 2; TH 11:30 – 12:30, by appointment, when door is open

TEACHING ASSISTANT INFORMATION
Office hours, names and email addresses will be posted on BlackBoard.
TAs will be available several hours during the week.

TEXTBOOK
Mechanics of Materials by Beer, Johnston, DeWolf, and Mazurek, 7th edition, 2015
(ebook is included with Connect. If you want a paper copy there are several options: buy "looseleaf" copy on connect sight, buy an older (less expensive) hard copy version since you have the etext with Connect, just use the etext (but you only have access to that during the semester)

Connect http://connect.mheducation.com/class/j-dannenhoffer-spring-2016

PREREQUISITES BY TOPIC
To succeed in this course, students should possess the knowledge and skills contained in the following courses:

- Engineering statics (ECS221)
- Calculus I (MAT295)
- Calculus II (MAT296)

COURSE LEARNING OBJECTIVES

At the completion of the course, each student should be able to:

A. Learn the fundamentals of **deformation and stress in solid bodies** (ABET *Civil Engineering Program Outcomes 1*)

1. apply the physical and geometrical meaning of normal stress, normal strain and volume strain in axially loaded members to engineering problems
2. apply the physical and geometrical meaning of shear and bearing stress and shear strain to engineering problems
3. apply the physical and geometrical meaning of torsional shear stress and torsional deformation in bars to engineering problems
4. use the relationships between loads, shear forces and bending moments in beams to analyze engineering problems
5. apply the physical and geometrical meaning of bending stress and curvature in beams to engineering problems
6. apply the physical and geometrical meaning of shear stress in beams to engineering problems
7. calculate plane stress and strain components in arbitrarily oriented elements; calculate principal stresses and strains and principal axes
8. apply the physical and geometrical meaning of stress and strain in thin walled cylindrical and spherical pressure vessels to engineering problems

B. Obtain an understanding of the **mechanical properties of various materials** (ABET *Civil Engineering Program Outcomes 1*)

1. be able to describe and identify the basic features of the stress-strain curve in tension and shear for a variety of materials
2. explain the effects of time and temperature on mechanical behavior
3. explain the physical meaning of the elastic and shear modulus, Poisson's ratio
4. explain the concepts of material homogeneity, isotropy and anisotropy

C. Acquire the ability to **predict stresses, deformations and failure in specific structural elements** subject to a variety of mechanical and thermal loadings (ABET *Civil Engineering Program Outcomes 1*)

1. solve statically determinate and indeterminate problems involving uniform and non-uniform axial and torsionally loaded members
2. solve for bending and shear stresses in statically determinate and indeterminate beams with symmetrical cross section and predict deflections of the beam axis
3. solve cylindrical and spherical pressure vessel problems
4. analyze beams, bars and vessels under combined loading
5. use energy methods to solve statically determinate and statically indeterminate truss and beam problems
6. predict buckling of columns under a variety of support conditions

<u>Outcome Measurement and Assessment</u>

- 15% Homework due at **beginning** of class on due date (no HW will be accepted at any other time, one HW grade will be dropped) Connect and written HW due on Thursday, Archimedes due Sunday by midnight
- 15% Quizzes- at beginning of class pop/announced quizzes, three quiz grade will be dropped
- 40% Three in-class exams (no exam grades will be dropped)
- 30% Final Exam Tuesday May 10, 2015, 3:00 – 5:00 pm (No final exam exemptions)

Homework.

- Reading of material pertinent to a given lecture should be done prior to the lecture.
- The solutions should be written clearly and neatly on the front side of an Engineering Worksheet. One Engineering Worksheet per problem (use second worksheet if additional space is needed with prob # and name on second sheet). On BB in Content.
- HW MUST be STAPLED
- When appropriate, EXCEL/MathCad plots are to be submitted. **Hand drawn plots are unacceptable.** Make sure your name is in the spreadsheet or MathCad printout.
- One letter grade penalty will be applied if HW is not stapled, written on Worksheet, or neat enough for the grader to read.
- Homework must be **submitted at the class start time on the due date**.
- No late homework will be accepted at any point during the semester.
    - **Do not drop off in my mailbox (I will throw it out)**
    - **Do not hand to TA/Grader after the beginning of class (they will not accept)**
- Students must write up the solutions independently. Duplicate, partially duplicate, or copied homework will receive a zero grade and other penalties may be imposed as well.
- HW must be handed in early if you will miss class for a school sanctioned athletic event/fieldtrip. A note with your name, the event, and the date you will be absent must be attached to the HW.

In class quizzes

- Short quizzes will be given almost daily. These will generally be of 5 minutes duration **at the start of class.**
- You must be on time or you will not have enough time to complete the quiz.
- There will also be slightly longer announced quizzes.
- THERE ARE NO MAKE-UP QUIZZES for any reason. Three quiz grades will be dropped.

Recitation

- Assignments will use a variety of platforms to reinforce learning in Mechanics of Solids including Archimedes and MathCad.

In-class and final examinations. (40%+30%)

- Three full period exams as well as a comprehensive final examination will be given during the semester. The exams will consist of problems that have not been previously assigned as homework. Feb. 15, Mar 24, April 25, May 10 (final)

Comprehensive course evaluation.

- Students will be asked to complete a comprehensive course evaluation at the end of the semester. The evaluation provides important feedback on course organization and materials, instructor and teaching assistant teaching styles, etc. This information plays a major role in the process of the continuous improvement of college programs. Your feedback during the semester is welcomed and appreciated.

Extra Credit

- There will NOT be any extra credit assignments. Be responsible during the semester. Keep up with work and ask for help when you need it.

Academic Integrity

Academic dishonesty will not be tolerated. In particular, cheating in any form on HW assignments, quizzes and exams is strictly prohibited. Although you are welcome to discuss HW problems with others, you must do your own work. Copying HW solutions from others is not allowed and is considered a violation of academic integrity. Cheating on a quiz or exam will result in automatically receiving a zero grade for that quiz or exam, and the matter will be referred to the College of Engineering and Computer Science Dean's office and the SU Academic Integrity office for further action. Please see http://academicintegrity.syr.edu.

Students With Disabilities

If you believe that you need accommodations for a disability, please contact the Office of Disability Services (ODS), http:/disablityservices.syr.edu, located at 804 University Avenue, room 309, or call (315) 443-4498 for an appointment to discuss your needs and the process for requesting accommodations. ODS is responsible for coordinating disability-related accommodations and when appropriate will provide **"Accommodation Authorization Letters"** to students with documented disabilities. Since accommodations may require early planning and are generally not provided retroactively, please contact ODS as soon as possible. Feel free to contact me privately to discuss your needs although I cannot arrange for accommodations.

Religious Observations

Students fill out their notification forms online. Make sure to check with me BEFORE your absence to make up any work.

1/19/2016

TOPICS

I. Tension, Compression and Shear
- a. Normal stress and strain.
- b. Mechanical properties of materials.
- c. Elasticity, plasticity and creep.
- d. Linear elasticity, Hooke's law, and Poisson's ratio.
- e. Shear stress and strain.
- f. Allowable stresses and allowable loads.

II. Axially Loaded Members
- a. Changes in length of axially loaded members.
- b. Changes in length of non-uniform bars.
- c. Statically indeterminate structures.
- d. Thermal effects.
- e. Stresses on inclined sections.
- f. Strain energy.

III. Torsion
- a. Torsional deformations of a circular bar.
- b. Circular bars of linearly elastic materials.
- c. Non-uniform torsion.
- d. Stresses and strains in pure shear.
- e. Relationship between moduli of elasticity E and G.
- f. Transmission of power by circular shafts.
- g. Statically indeterminate torsional members.
- h. Strain energy in torsion and pure shear.

IV. Shear Forces and Bending Moments
- a. Types of beams, loads and reactions.
- b. Shear forces and bending moments.
- c. Relationships between loads, shear forces and bending moments.
- d. Shear-force and bending -moment diagrams.

V. Stresses in Beams
- a. Pure bending and non-uniform bending.
- b. Curvature of a beam.
- c. Longitudinal strains in beams.
- d. Normal stresses in beams (linear elastic materials).
- e. Design of beams for bending stresses.
- f. Non-prismatic beams.
- g. Shear stresses in beams of rectangular cross section.
- h. Shear stresses in beams of circular cross section.
- i. Shear stresses in the webs of beams with flanges.
- j. Built-up beams and shear flow.
- k. Beams with axial loads.

VI. Analysis of Stress and Strain

a. Plane stress.
b. Principal stresses and maximum shear stresses.
c. Mohr's circle for plane stress.
d. Hooke's law for plane stress.
e. Triaxial stress.
f. Plane strain.

VII. Applications of Plane Stress
a. Spherical pressure vessels.
b. Cylindrical pressure vessels.
c. Maximum stresses in beams.
d. Combined loadings.

VIII. Deflections of Beams
a. Differential equations of the deflection curve.
b. Deflections by integration of the bending-moment equation.
c. Deflections by integration of the shear-force and load equations.
d. Method of superposition.
e. Non-prismatic beams.
f. Strain energy of bending.

IX. Statically Indeterminate Beams
a. Types of statically indeterminate beams.
b. Analysis by the differential equations of the deflection curve.
c. Method of superposition.

X. Columns
a. Buckling and stability.
b. Columns with pinned ends.
c. Columns with other support conditions.
d. Columns with eccentric axial loads.[1]
e. The secant formula for columns.[1]

XI. Energy Methods
a. Strain energy expressions for structural members.
b. Displacements under a single load.
c. Displacements under general loading; Castigliano's Theorem[1]
d. Indeterminate structures.
e. Applications to beams, frames, trusses.

[1] Time permitting.