

Lecture 1 - Equilibrium

Dr. Nicholas Smith

Wichita State University, Department of Aerospace Engineering

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schedule

- 1 Feb - Introduction, Equilibrium
- 3 Feb - Stress
- 8 Feb - Strain, Homework 1 Due
- 10 Feb - Mechanical Properties

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- introduction
- syllabus
- mechanics
- equilibrium

introduction



education

- B.S. in Mechanical Engineering from Brigham Young University
 - Worked with ATK to develop tab-less gripping system for tensile testing composite tow specimens
 - Needed to align the specimen, as well as grip it without causing a stress concentration

- M.S. and Ph.D. from School of Aeronautics and Astronautics at Purdue University
 - Worked with Boeing to simulate mold flows
 - First ever mold simulation with anisotropic viscosity

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Figure 1: picture of chopped carbon fiber prepreg

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Figure 2: picture of lamborghini symbol made from compression molded chopped carbon fiber

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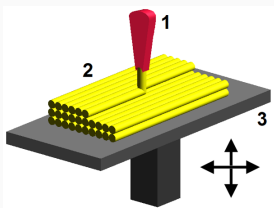


Figure 3: picture illustrating the fused deposition modeling 3D printing process, where plastic filament is melted and deposited next to other filament, and fuses together

- Composites are being used in 3D printing now
- Printing patterns are optimized for isotropic materials
- Sometimes composites hurt more than they help when not utilized properly

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- Name
- One interesting thing to remember you by

syllabus and schedule

- R.C. Hibbeler - Mechanics of Materials
- This semester I am changing how I do homework, and MasteringEngineering will NOT be used

office hours

- No traditional office hours this year
- Office appointments can be scheduled via e-mail, although remote meetings are preferred

tentative course outline

- Section 1 - stress, strain, mechanical properties
- Ch 1 - Stress (1 Feb)
- Ch 2 - Strain (3 Feb)
- Ch 3 - Mechanical Properties (8 Feb)
- Exam 1 (15 Feb)
- Project 1 (19 Feb)

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tentative course outline

- Section 2 - loading
- Ch 4 - Axial Load (17 Feb)
- Ch 5 - Torsion (24 Feb)
- Ch 6 - Bending (3 Mar)
- Ch 7 - Transverse Shear (10 Mar)
- Exam 2 (22 Mar)
- Project 2 (26 Mar)

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tentative course outline

- Section 3 - beams, shafts, combined loading
- Ch 8 - Combined Loading (22 Mar)
- Ch 9 - Stress Transformation (29 Mar)
- Ch 10 - Strain Transformation (5 Apr)
- Ch 12 - Deflection of Beams and Shafts (12 Apr)
- Exam 3 (21 Apr)
- Project 3 (23 Apr)

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tentative course outline

- Section 4 - buckling, stress concentration
- Ch 4.7, 5.8, 6.9 - Stress concentration (26 Apr)
- Ch 13 - Buckling (28 Apr)
- Final Exam (comprehensive) (10 May)

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grades

- Grade breakdown
- Homework 5%
- Exam 1 15%
- Exam 2 15%
- Exam 3 15%
- Final Exam 20%
- Project 1 10%
- Project 2 10%
- Project 3 10%

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grades

- Follow a traditional grading scale
- (80% B-, 83% B, 87% B+, etc.)

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curve

- I do NOT curve final grades
- Instead, each individual exam is curved on a best-fit linear scale
- This scale is somewhat subjective, best score is mapped to 100, I pick one other score to map that I feel is representative of a C or a B
- The end goal of this curve is to get a standard deviation close to 10% and a class average representative of the performance on the exam, usually between a C and a B

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class expectations

- Consider the cost (to you or others) of your being in class
- I ask that you refrain from distracting behaviors during class
- When you have something more important than class to take care of, please take care of it outside of class
- Chegg

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homework

- In general, homework assignments will be due every Friday by midnight
- Homework will be submitted online via Blackboard, half the homework credit will be granted for completion.
- Late homework will not be accepted

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self-grade

- Your homework will be self-graded, your self-grading will generally be due the week after the original assignment
- Homework solutions will be posted to Blackboard, and the remaining half of the homework credit will be assigned after you complete (and submit) your self-grade.
- You do not lose credit for incorrect answers, but your self-grade should explain the differences between your answer and the correct solution.
- Some problems will be somewhat open-ended and there may not be a “correct” answer, so consider that when looking at what is different between your solution and mine

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mechanics

mechanics

- Generally subdivided into three branches
- Rigid-body mechanics
- Deformable-body mechanics
- Fluid mechanics

- Statics - bodies in equilibrium (rest or constant velocity)
- Dynamics - bodies under accelerated motion ($F = ma$)

equilibrium of a deformable body

- Surface loads act on the surface of a body, can be either concentrated forces or distributed loads
- Body forces are developed inside a body, some examples are gravity or electromagnetic fields

support reactions

- In general, if a support prevents translation in a given direction, then a reaction force must be developed in that direction
- Similarly, if a support prevents rotation about an axis, then a couple moment must be developed about that axis

equilibrium

- For a body to be in equilibrium the balance of forces and the balance of moments must both be zero

$$\sum F_i = 0$$

$$\sum M_i = 0$$

- For 2D problems, this reduces to

$$\sum F_x = 0$$

$$\sum F_y = 0$$

$$\sum M_O = 0$$

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internal resultant loadings

- We use statics to find resultant loadings acting within a body
- This is done using the method of sections

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internal resultant loadings

- Normal Force, N - acts perpendicular to an area
- Shear Force, V - lies in the plane of an area, causes two segments to slide over one another
- Torsional Moment, T - tendency to twist about an axis perpendicular to an area
- Bending Moment, M - tendency to bend the body about an axis lying within the plane of the area

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planar problems

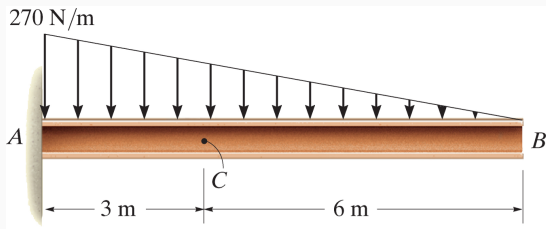
- In planar problems, where all forces lie in the same plane, we only have
 - Normal Force
 - Shear Force
 - Bending Moment

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- Support reactions
- Free body diagram
- Equations of equilibrium

examples

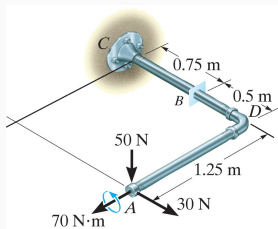
example 1.1



Find the internal forces at point C.

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example 1.4



Find the internal forces at point D.

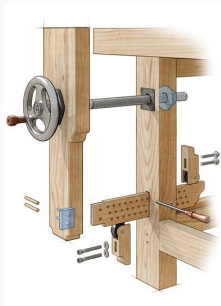
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example

Compare three cases for a traditional leg vise for use on Dr. Smith's workbench - No bottom support - Standard pin-board - St. Peter's Cross - NOTE: Assume the force applied at the vise is the same in all cases (around 2000 lb if you want a number), that the leg vise is 3 ft. tall and the screw is 1 ft. down from the top.

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traditional pin-board



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