AE333

Mechanics of Materials

Lecture 1 - Equilibrium Dr. Nicholas Smith
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January 22, 2020

schedule

- 23 Jan - Introduction, Equilibrium
- 25 Jan - Stress
- 28 Jan - Average stress, Intro HW Due
- 30 Jan - Assessment Test

outline

- introduction
- syllabus
- mechanics
- equilibrium

introduction

about me


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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

education

- 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

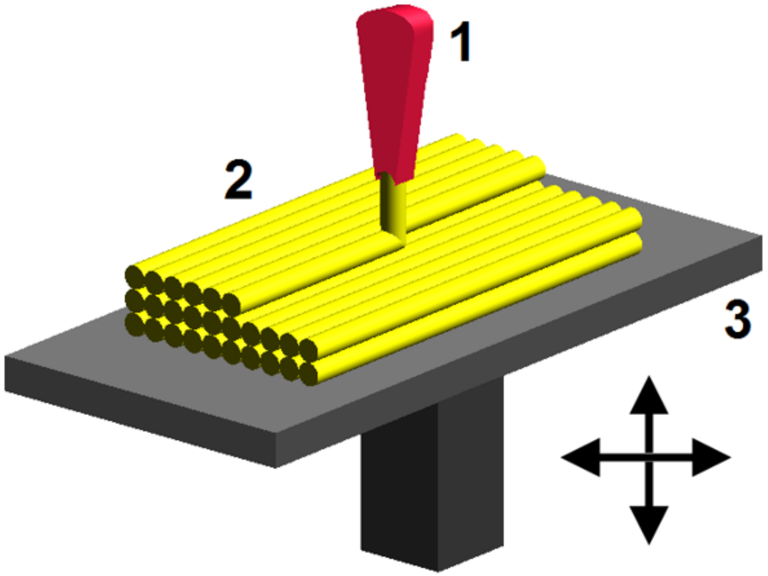
research

research

research

- No simulation is currently able to predict fiber orientation from these processes
- Part of the challenge is that we only have information from initial state and final state
- I want to quantify intermediate stages using a transparent mold

research



- 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

introductions

- Name
- One interesting thing to remember you by

syllabus and schedule

course textbook

- R.C. Hibbeler - Mechanics of Materials
- We WILL be using Mastering Engineering for homework, so you will need a license/account for that to submit homework assignments

office hourse

- I will e-mail everyone in the course a Doodle link we can use to find the optimal office hours
- Let me know if you do not receive the e-mail, you may need to update your information in Blackboard
- If the regular office hours do not work for your schedule, send me an e-mail and we can work out a time to meet

tentative course outline

- Section 1 - stress, strain, mechanical properties
    - Ch 1 - Stress (23 Jan)
    - Ch 2 - Strain (30 Jan)
    - Ch 3 - Mechanical Properties (4 Feb)
    - Exam 1 (8 Feb)

tentative course outline

- Section 2 - loading
  - Ch 4 - Axial Load (11 Feb)
  - Ch 5 - Torsion (18 Feb)
  - Ch 6 - Bending (25 Feb)
  - Ch 7 - Transverse Shear (4 Mar)
  - Exam 2 (8 Mar)

tentative course outline

- Section 3 - beams, shafts, combined loading
    - Ch 8 - Combined Loading (18 Mar)
    - Ch 9 - Stress Transformation (25 Mar)
    - Ch 10 - Strain Transformation (1 Apr)
    - Ch 12 - Deflection of Beams and Shafts (8 Apr)
    - Exam 3 (26 Apr)

tentative course outline

- Section 4 - buckling, stress concentration
  - Ch 4.7, 5.8, 6.9 - Stress concentration (29 Apr)
  - Ch 13 - Buckling (6 May)
  - Final Exam (comprehensive) (15 May)

grades

- Grade breakdown
    - Assessment Test 2%
    - Class Participation 3%
    - Homework 10%
    - Exam 1 20%
    - Exam 2 20%
    - Exam 3 20%
    - Final Exam 25%

grades

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

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

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

homework

- In general, homework assignments will be due every Monday by midnight
- We use Mastering Engineering for homework in this class
- You are allowed 5 incorrect answers (-3% for each incorrect answer)
- The first assignment is graded as pass/fail and is to help you become familiar with the online homework system

assessment test

- The assessment test will be graded, and accounts for 2% of your final grade
- You should do your best, but it is meant as a measure of what you have learned before starting this class, so no study or preparation materials will be provided
- You will be provided with an equation sheet taken from the inside cover of your textbook
- Bring a scientific calculator (capable of sine and cosine)

assessment test topics

- Vector mechanics (cartesian vector notation, summation of vectors)
- Friction (static coefficient of friction)
- Dot product
- Torque (i.e. moment due to offset forces)
- Equilibrium (extension of vector mechanics)

assessment test

- Test will consist of both multiple choice and working problems
- The test will be fixed at 50 minutes
- The purpose is to determine how well-prepared you are for mechanics of materials
- We are trying to determine which students need extra help (both you individually and in general for future students), this test is part of ongoing research and is optionally accompanied by a survey

mechanics

mechanics

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

rigid-body mechanics

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

equilibrium of a deformable body

loads

- 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

internal resultant loadings

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

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

planar problems

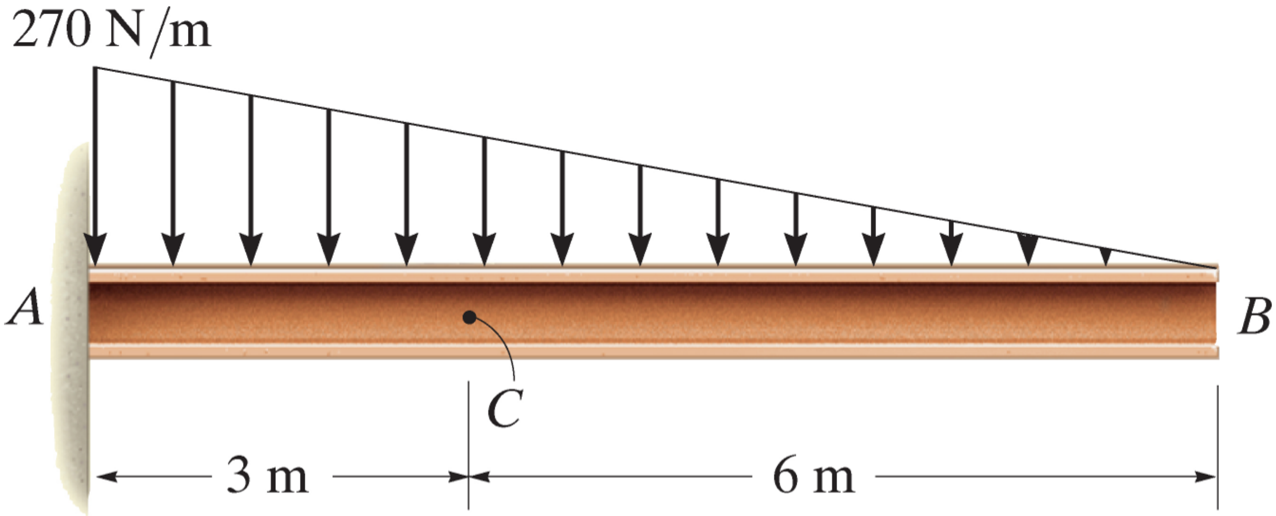
- In planar problems, where all forces lie in the same plane, we only have
    - Normal Force
    - Shear Force
    - Bending Moment

summary

- Support reactions
- Free body diagram
- Equations of equilibrium

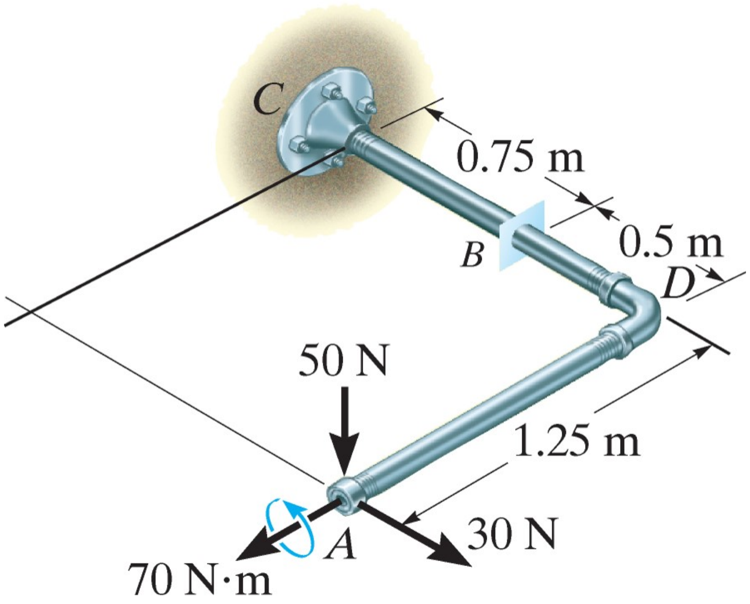
examples

example 1.1



Find the internal forces at point C.

example 1.4



Find the internal forces at point D.