

Fostering Active Learning: Using Interactive Tools to Enhance Engagement and Participation

CIE 202 (Mechanics of Materials) – Spring 2025

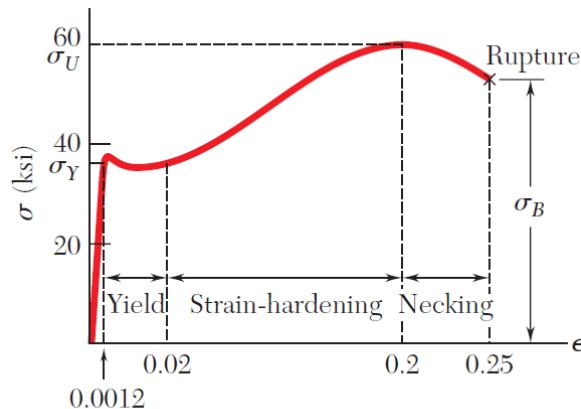
April 22, 2025

Hamza Jaffal

Course Description

CIE 202: Mechanics of Materials – Spring 2025

- Required course for **Civil, Mechanical, and Petroleum Engineering**
- Registered by **first and second year** students
- Spring 2025 section consisted of **7 students**



(a) Low-carbon steel

Beer et al. (2009). *Statics and Mechanics of Materials*



Golden Gate Bridge, California – June 2023

Course Learning Outcomes:

1. **Calculate** stresses and strains in axially loaded members.
2. **Analyze** statically indeterminate structures.
3. **Apply** stress transformation to find stresses at different orientations.
4. **Estimate** deflections of beams and shafts by integration.
5. **Design** members subjected to axial load, bending moment, torsion, and shear.

Course Outline

Outline:

1. Statics Review
2. Concepts of Stress
3. Stress and Strain – Axial Loading
4. Torsion
5. Pure Bending
6. Shearing Stresses in Beams and Thin-Walled Members
7. Transformation of Stresses
8. Deflection of Beams

Activities:

- > • Padlet Poll
- > • Flipped Classroom - 1
- > • Padlet Poll
- > • Padlet Poll
- > • Padlet Poll
- > • Flipped Classroom – 2
- > • Padlet Poll

Grade Distribution

Old

Homework/Participation	10%
Exams 1, 2, and 3	50%
Final Exam	40 %

Grade Distribution

Old

Homework/Participation	10%
Exams 1, 2, and 3	50%
Final Exam	40 %



New

Homework	5%
Participation	5%
Exams 1, 2, and 3	50%
Final Exam	40 %

Grade Distribution

Old

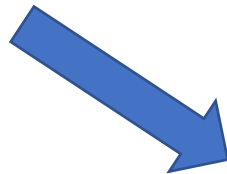
Homework/Participation	10%
Exams 1, 2, and 3	50%
Final Exam	40 %

Course outline:

1. Statics Review
2. Concepts of Stress Chapter 8
3. Stress and Strain – Axial Loading Chapter 9
4. Torsion Chapter 10
5. Pure Bending Chapters 11,12
6. Shearing Stresses in Beams and Thin-Walled Members Chapter 13
7. Transformation of Stresses Chapter 14
8. Deflection of Beams Chapter 15

Activities:

- Padlet Poll
- Flipped Classroom - 1
- Padlet Poll
- Padlet Poll!
- Padlet Poll
- Flipped Classroom – 2
- Padlet Poll



New

Homework	5%
Participation	5%
Exams 1, 2, and 3	50%
Final Exam	40 %

Learning Tools

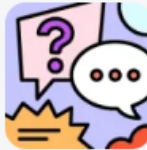
For more interactive learning

Perusall[®]

 **padlet**



Assessment polls



Discussion board

New



Padlet



Center for Innovative Learning

Poll

Home / Gallery / Learn / Join / + Make

Hamza Jaffal

Hi, Hamza
Remember to eat your
veggies!

Search padlets

Recents

All padlets

Made by me

Trashed

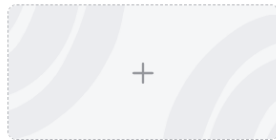
Bookmarks

Favorites

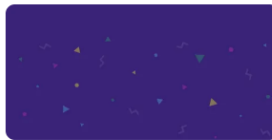
New folder

All padlets

Name Last modified



Make a padlet



QA Board
Hamza Jaffal • 17m



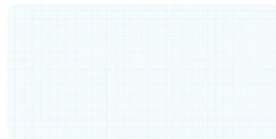
Assessment Polls: Mohr Circle
Hamza Jaffal • 11d



Assessment Polls: Shear
Stress in Beams and Thin-...
Hamza Jaffal • 23d



Assessment Polls: Deflection
of Beams
Hamza Jaffal • 1mo



Assessment Polls: Torsion
Hamza Jaffal • 1mo



Assessment Polls: Pure
Bending
Hamza Jaffal • 1mo



Assessment Polls:
Temperature Loading in...
Hamza Jaffal • 3mo



Assessment Polls: Axial
Loading
Hamza Jaffal • 3mo



Final Project Presentations
Jordan Srour • 4mo





Padlet



Center for Innovative Learning

Poll

Home / Gallery / Learn / Join / + Make

Hamza Jaffal

Hi, Hamza
Remember to eat your
veggies!

- Start from scratch
- AI recipes
- Your templates
- Recipes

Make a padlet

Blank board

Wall, Canvas, Timeline, Grid, Stream, Map

See examples

Blank sandbox

Draw, create, and play in real-time with others

See examples

AI recipes BETA

- Discussion board New
- Class activity creator New
- Lesson plan
- Ideas for class activities
- Timeline of events
- Reading list
- Map of historical events
- Assessment polls
- Rubric
- Custom board

Your templates



Poll

Assessment Polls: Torsion

Advanced level quizzes for Torque diagram, Shear stress due to Torque, Angle of Twist

What does a torque diagram represent?

- Shear force at various points
- Deflection of a beam
- Distribution of bending stress
- Variation of torque along the length of a shaft

7 votes • Show Results

The shear stress in a circular shaft due to torque acts:

- Radially inwards
- Along the length of the shaft
- Tangentially to the shaft surface
- At an angle of 45 degrees

7 votes • Show Results

Which is the correct formula for shear stress due to torque?

- $\tau = P/A$
- $\tau = Tc/J$
- $\tau = E\theta/L$
- $\tau = MV/I$

7 votes • Show Results

What is necessary to calculate the angle of twist?

- Cross-sectional area and length
- Torque, length, material's modulus of rigidity, and polar moment of inertia
- Only the material's stiffness
- Torque and Young's modulus

7 votes • Show Results

What does the polar moment of inertia quantify?

- Stiffness of a beam
- Lateral strain
- Resistance to twisting
- Resistance to bending

7 votes • Show Results

In solid circular shafts, the shear stress varies:

- Exponentially with radius
- Linearly from the axis to the surface
- Only near the surface
- Uniformly throughout

7 votes • Show Results

What happens to the angle of twist if the length of the shaft is doubled?

- It doubles
- It remains the same
- It quadruples
- It gets halved

7 votes • Show Results

Which material property is needed to determine shear stress due to torque?

- Modulus of rigidity
- Thermal conductivity
- Young's modulus
- Ultimate tensile strength

6 votes • Show Results



Padlet



Poll

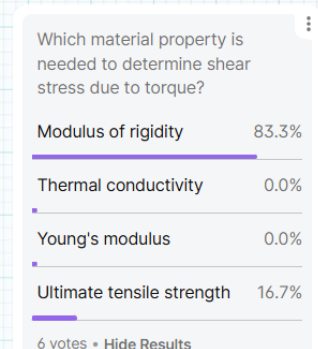
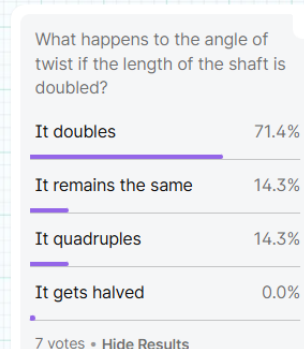
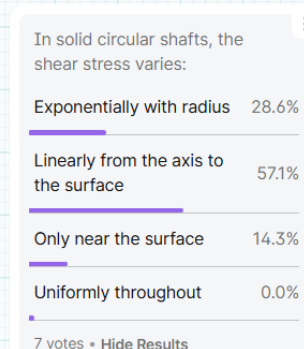
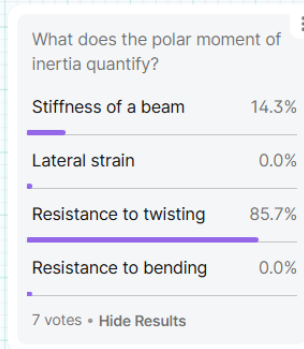
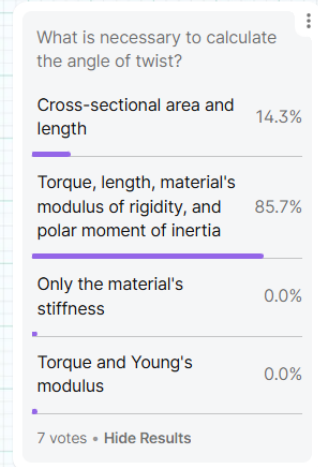
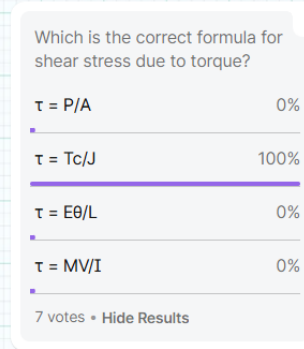
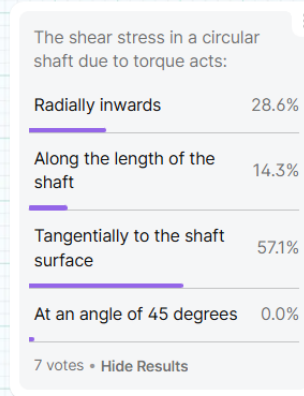
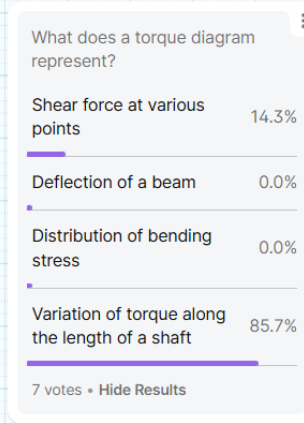




Poll

Assessment Polls: Torsion

Advanced level quizzes for Torque diagram, Shear stress due to Torque, Angle of Twist





Padlet



Center for
Innovative Learning

Poll

Creating a Poll using AI assistant



Discussion Board

Home / Gallery / Learn / Join / + Make

Hamza Jaffal

Hi, Hamza
Remember to eat your
veggies!

- Start from scratch
- AI recipes
- Your templates
- Recipes

Make a padlet

Blank board


Wall, Canvas, Timeline, Grid, Stream, Map



See examples

Blank sandbox

Draw, create, and play in real-time with others



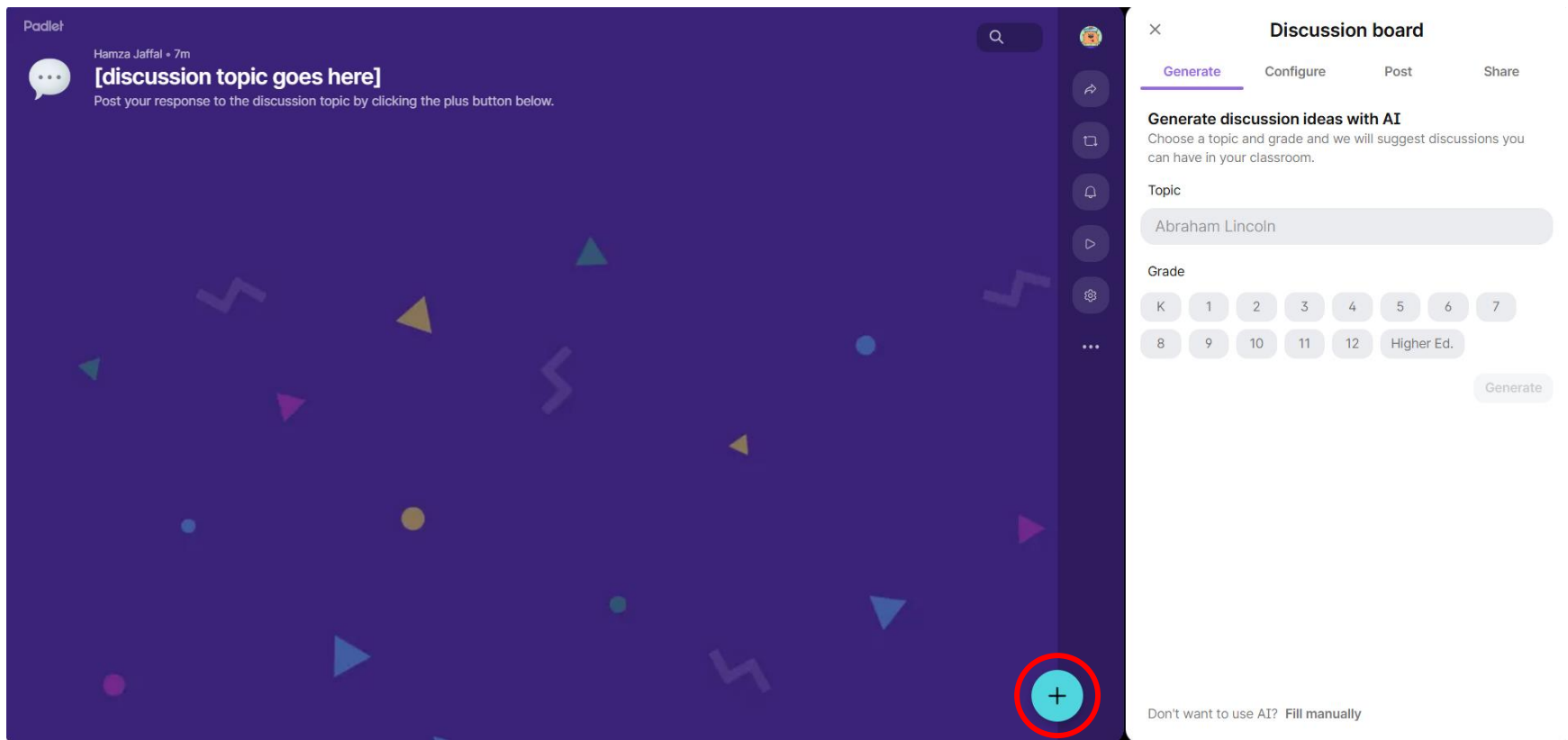
See examples

AI recipes BETA

- Discussion board** New
- Class activity creator New
- Lesson plan
- Ideas for class activities
- Timeline of events
- Reading list
- Map of historical events
- Assessment polls
- Rubric
- Custom board

Your templates

Discussion Board



Padlet

Hamza Jaffal • 7m

[discussion topic goes here]

Post your response to the discussion topic by clicking the plus button below.

Discussion board

Generate Configure Post Share

Generate discussion ideas with AI

Choose a topic and grade and we will suggest discussions you can have in your classroom.

Topic

Abraham Lincoln

Grade

K 1 2 3 4 5 6 7 8 9 10 11 12 Higher Ed.

Generate

Don't want to use AI? Fill manually

Course

Perusall® Catalog My purchases Get help HJ Hamza Jaffal

Create

- Course**
Teach a course and deliver your course materials to students with social learning.
- Workshop**
Lead a workshop to solicit feedback on your manuscripts.
- Book or journal club**
Organize a book or journal club to discuss books from our catalog or your own uploaded content.

Join

- PerusHall**
Join the community of instructors, course designers, and administrators using Perusall around the world.
- Enter enrollment code**
Join a course, workshop, or club using an enrollment code.

My courses

Sort by: Name, A-Z

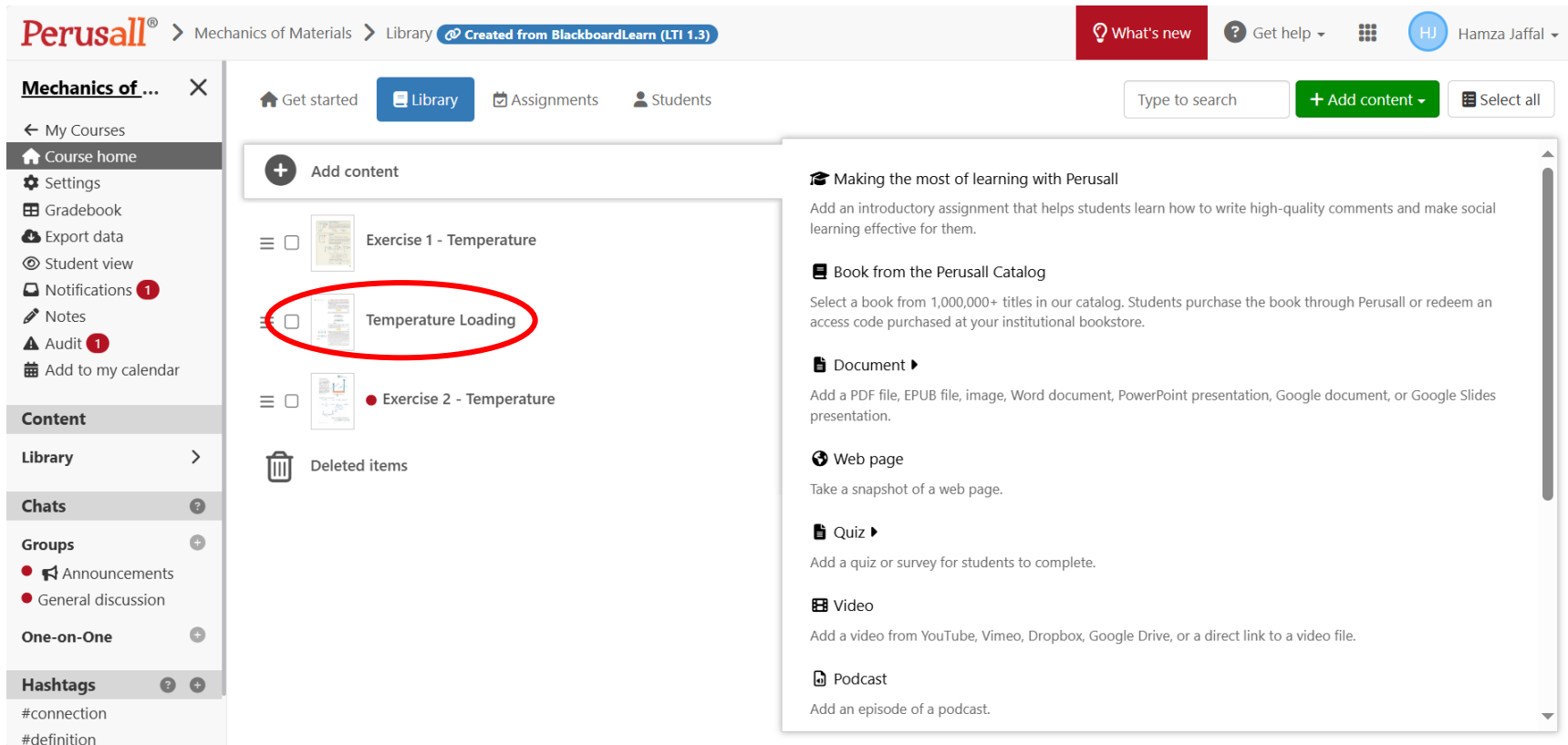
Engineering Mechanics 36 students, 1 item in library	Created from BlackboardLearn (LTI 1.3) Started January 14, 2025 / Ends July 14, 2025
Mechanics of Materials 7 students, 3 items in library	Created from BlackboardLearn (LTI 1.3) Started January 14, 2025 / Ends July 14, 2025

My archived spaces

Faculty Fellows Program Started May 29, 2024 / Ended on November 29, 2024	Created from BlackboardLearn (LTI 1.3)
Faculty Fellows Reading Started May 15, 2024 / Ended on July 4, 2024	

My workshops and clubs

Document



The screenshot displays the Perusall interface for a course titled "Mechanics of Materials". The breadcrumb navigation shows the path: Mechanics of Materials > Library > Created from BlackboardLearn (LTI 1.3). The user is identified as Hamza Jaffal.

The left sidebar contains navigation options: My Courses, Course home, Settings, Gradebook, Export data, Student view, Notifications (1), Notes, Audit (1), and Add to my calendar. Below this are sections for Content, Library, Chats, Groups, and One-on-One, followed by Hashtags.

The main content area shows the "Library" tab selected. Under "Add content", there are three items: "Exercise 1 - Temperature", "Temperature Loading" (highlighted with a red circle), and "Exercise 2 - Temperature". A "Deleted items" section is also visible.


The right sidebar provides instructions for adding content:

- Making the most of learning with Perusall**: Add an introductory assignment that helps students learn how to write high-quality comments and make social learning effective for them.
- Book from the Perusall Catalog**: Select a book from 1,000,000+ titles in our catalog. Students purchase the book through Perusall or redeem an access code purchased at your institutional bookstore.
- Document**: Add a PDF file, EPUB file, image, Word document, PowerPoint presentation, Google document, or Google Slides presentation.
- Web page**: Take a snapshot of a web page.
- Quiz**: Add a quiz or survey for students to complete.
- Video**: Add a video from YouTube, Vimeo, Dropbox, Google Drive, or a direct link to a video file.
- Podcast**: Add an episode of a podcast.

Tracking

+ Add content

- Exercise 1 - Temperature
- Temperature Loading
- Exercise 2 - Temperature
- Deleted items



Temperature Loading

Open

Replace file

Edit

Clear digital rights

Assign

Groups

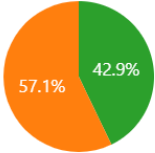
Delete

Analytics

Download document

Download document with comments

Overall progress



●	Posted comments (42.9%)
●	Accessed content but no comments (57.1%)
●	Content not accessed (0%)

9 comments, **4** questions, **1** unanswered question

36 minutes average active engagement time

Tracking

+ Add content

- Exercise 1 - Temperature
- Temperature Loading
- Exercise 2 - Temperature
- Deleted items

Most active students

- MA (3 comments)
- RY (2 comments)
- HA (1 comment)

Least active students

- TS (0 comments)
- SA (0 comments)
- JC (0 comments)
- AM (0 comments)
- HA (1 comment)
- RY (2 comments)
- MA (3 comments)

Activities:

1 – Temperature Loading:

- Perusal reading
- Padlet poll
- In-class group activity

2 – Stress Transformation:

- Study of a slide
- Padlet discussion board
- Excel sheet demo
- Padlet poll
- In-class group activity

Activities:

1 – Temperature Loading:

- Perusal reading
- Padlet poll
- In-class group activity

2 – Stress Transformation:

- Study of a slide
- Padlet discussion board
- Excel sheet demo
- Padlet poll
- In-class group activity

1 – Temperature Loading



368 Stress and Strain—Axial Loading

9.9 PROBLEMS INVOLVING TEMPERATURE CHANGES

All of the members and structures that we have considered so far were assumed to remain at the same temperature while they were being loaded. We are now going to consider various situations involving changes in temperature.

Let us first consider a homogeneous rod AB of uniform cross section, which rests freely on a smooth horizontal surface (Fig. 9.28a). If the temperature of the rod is raised by ΔT , we observe that the rod elongates by an amount δ_T which is proportional to both the temperature change ΔT and the length L of the rod (Fig. 9.28b). We have

$$\delta_T = \alpha(\Delta T)L \quad (9.20)$$

where α is a constant characteristic of the material, called the *coefficient of thermal expansion*. Since δ_T and L are both expressed in

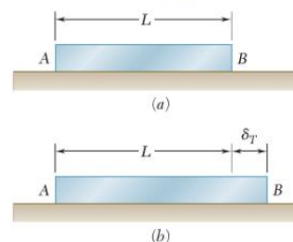
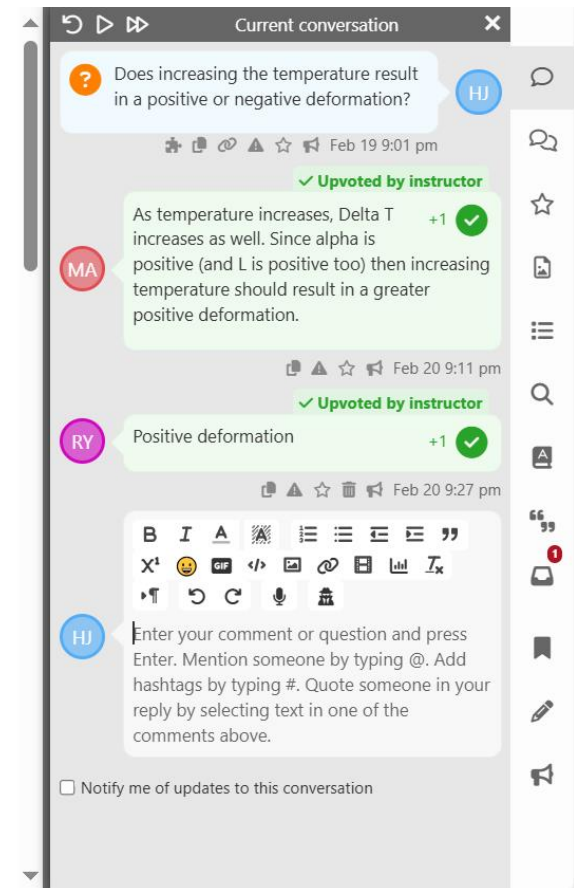


Fig. 9.28

units of length, α represents a quantity *per degree C*, or *per degree F*, depending whether the temperature change is expressed in degrees Celsius or in degrees Fahrenheit



The screenshot shows a 'Current conversation' window with the following content:

- Question: "Does increasing the temperature result in a positive or negative deformation?" (HJ)
- Answer (MA): "As temperature increases, Delta T increases as well. Since alpha is positive (and L is positive too) then increasing temperature should result in a greater positive deformation." (Upvoted by instructor)
- Answer (RY): "Positive deformation" (Upvoted by instructor)

The interface includes a text input field at the bottom with a placeholder: "Enter your comment or question and press Enter. Mention someone by typing @. Add hashtags by typing #. Quote someone in your reply by selecting text in one of the comments above." There are also icons for formatting, emojis, and other chat functions.

1 – Temperature Loading



Assessment Polls: Temperature Loading in Engineering

Advanced-level assessment polls for higher education students on the topic of temperature loading.

What is the primary effect of temperature loading on a material?

Expansion or contraction of the material 100%

Change in color of the material 0%

Transformation into a liquid state 0%

Alteration of electrical conductivity 0%

7 votes • Hide Results

Which equation is used to calculate thermal strain due to temperature change?

$\epsilon = \alpha \Delta T$ 100%

$PV = nRT$ 0%

$F = kx$ 0%

$\sigma = E\epsilon$ 0%

7 votes • Hide Results

What property determines a material's expansion under temperature loading?

Poisson's ratio 0%

Density of the material 0%

Electrical resistivity 0%

Coefficient of thermal expansion 100%

7 votes • Hide Results

What happens to a fixed-end beam under temperature rise?

Undergoes plastic deformation 0.0%

Loses tensile strength 0.0%

Develops thermal stress 85.7%

Bends downward 14.3%

7 votes • Hide Results

In which unit is the coefficient of thermal expansion typically expressed?

(1/°C) or (1/K) 85.7%

J/kg·K 0.0%

Pa·s 14.3%

N/m² 0.0%

7 votes • Hide Results

A fixed-end beam undergoes a temperature drop of 10°C. $\alpha = 15 \times 10^{-6} / ^\circ\text{C}$, and $E = 150 \text{ GPa}$. What is the stress caused by the temperature change?

0 0.0%

Cross sectional area is need 0.0%

22.5 MPa Tension 71.4%

22.5 MPa Compression 28.6%

A 2 m long steel bar elongates by 0.3 cm when heated by 15 °C. Calculate α .

0.01 °C 0.0%

0.01 1/°C 14.3%

0.0001 °C 57.1%

0.0001 1/°C 28.6%

7 votes • Hide Results

1 – Temperature Loading



Activities

1 – Temperature Loading:

- Perusal reading
- Padlet poll
- In-class group activity

2 – Stress Transformation:

- Study of a slide
- Padlet discussion board
- Excel sheet demo
- Padlet poll
- In-class group activity

2 – Stress Transformation

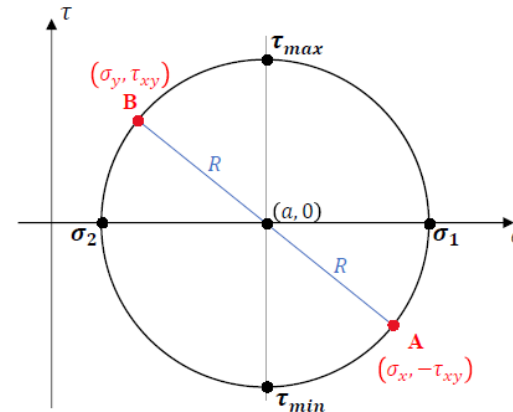
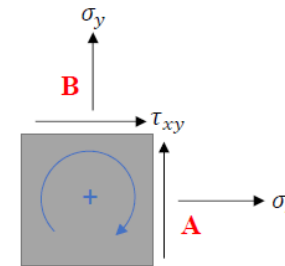
CIE202 – Chapter 14



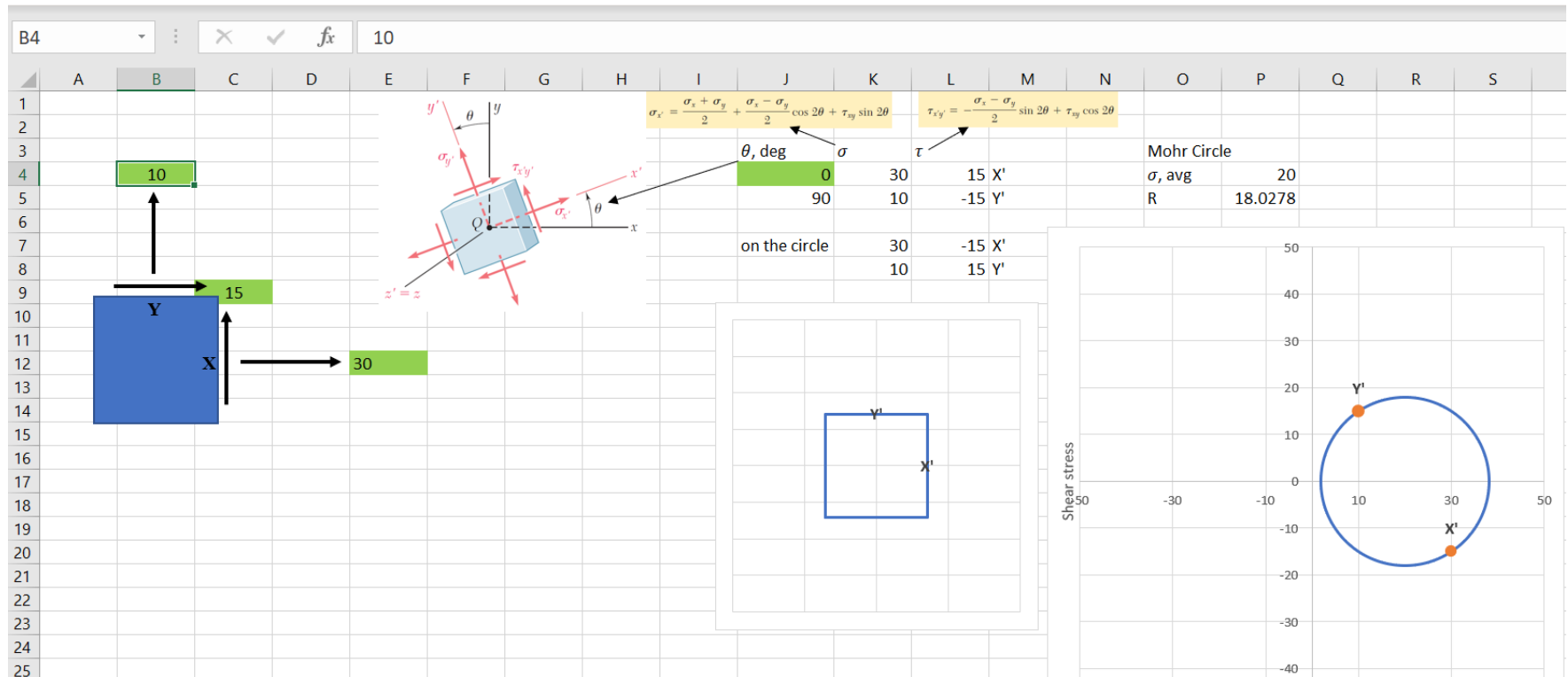
Stress Transformation in 2D (Mohr Circle):

Notes: *(excel demonstration)*

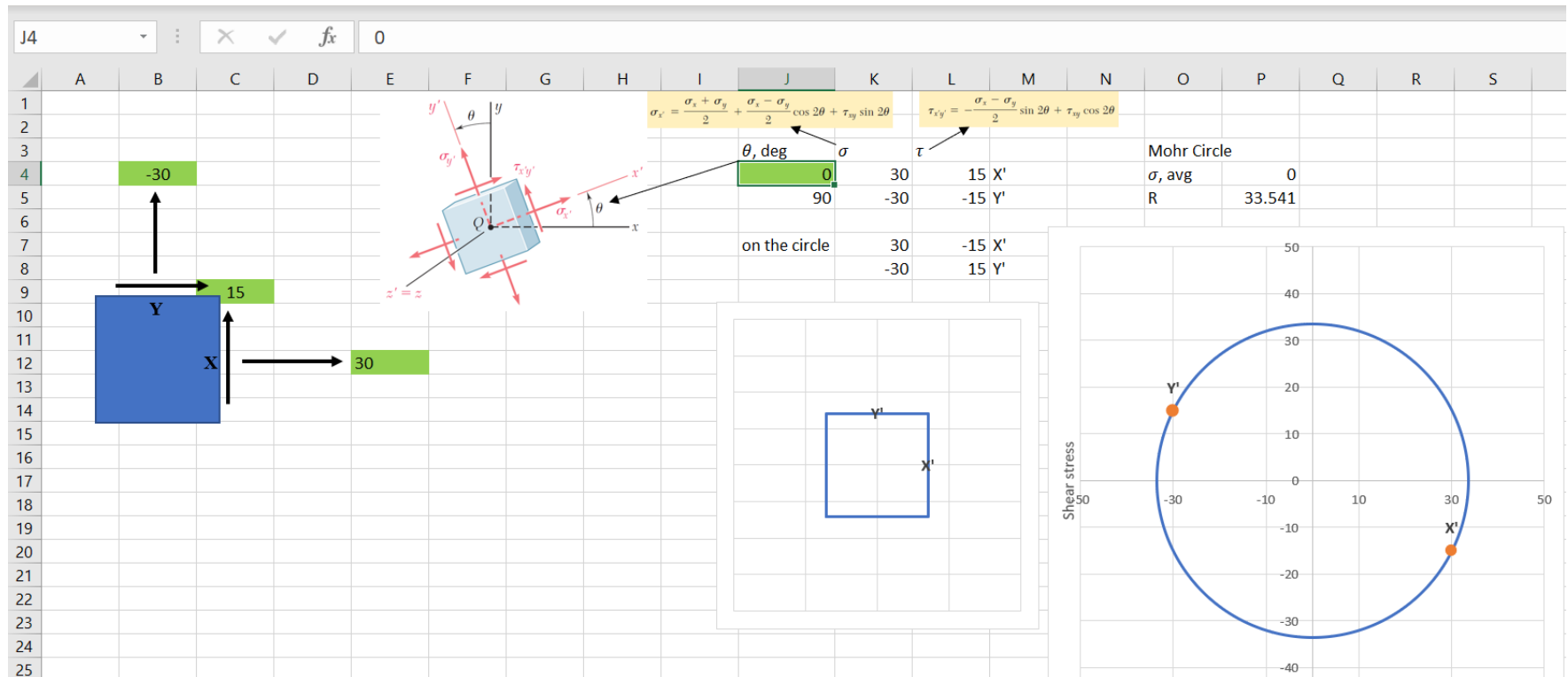
- Stresses on two perpendicular planes plot on two diametrically opposite points on the Mohr circle
- **General:** a plane rotating by an angle θ corresponds to a point rotating by an angle 2θ on the circle, in the same direction.
- At σ_1 and σ_2 , $\tau = 0$, and σ_1 and σ_2 are called principal stresses
- $\tau_{max} = R$
- If $\sigma_1 = \sigma_2$, the circle collapses into a point \rightarrow no shear
- The sum of normal stresses on any two mutually perpendicular planes is constant and $= \sigma_x + \sigma_y$



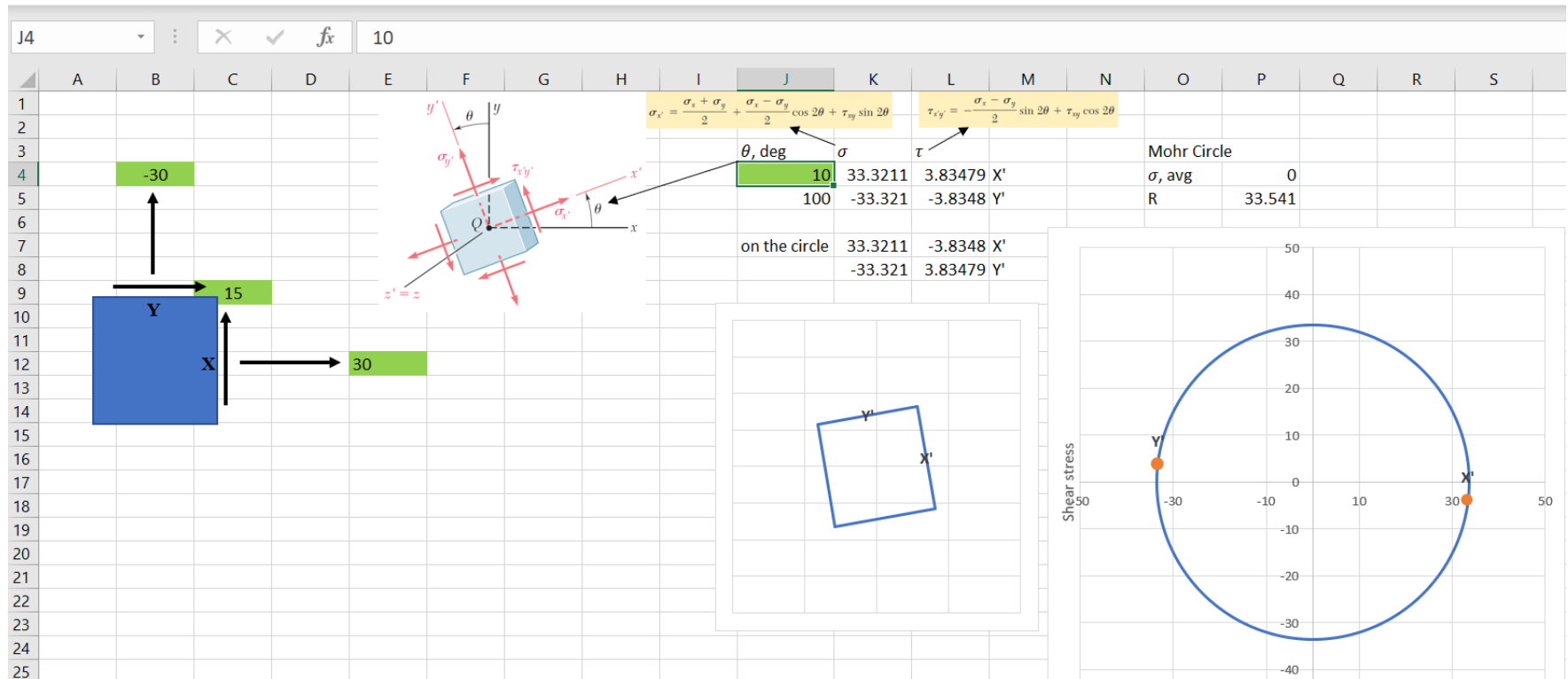
2 – Stress Transformation



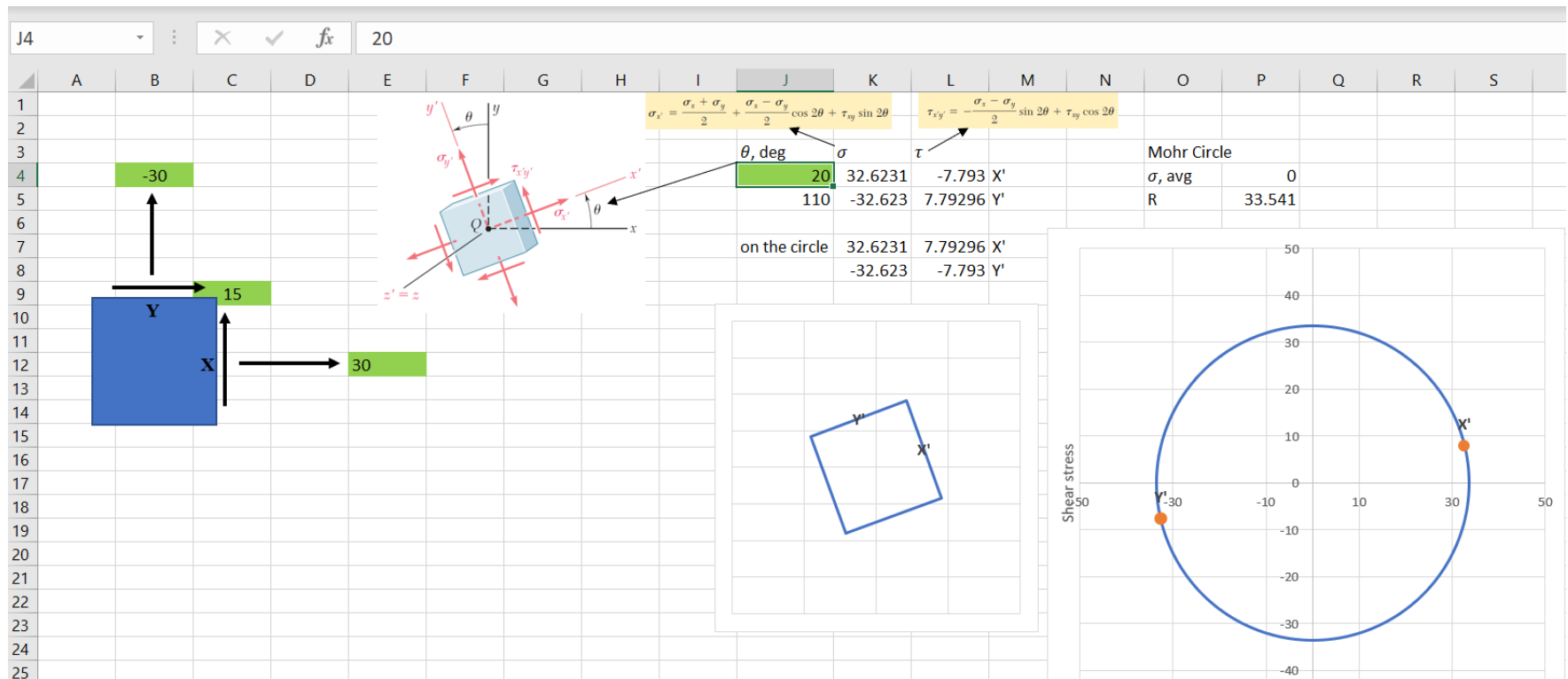
2 – Stress Transformation



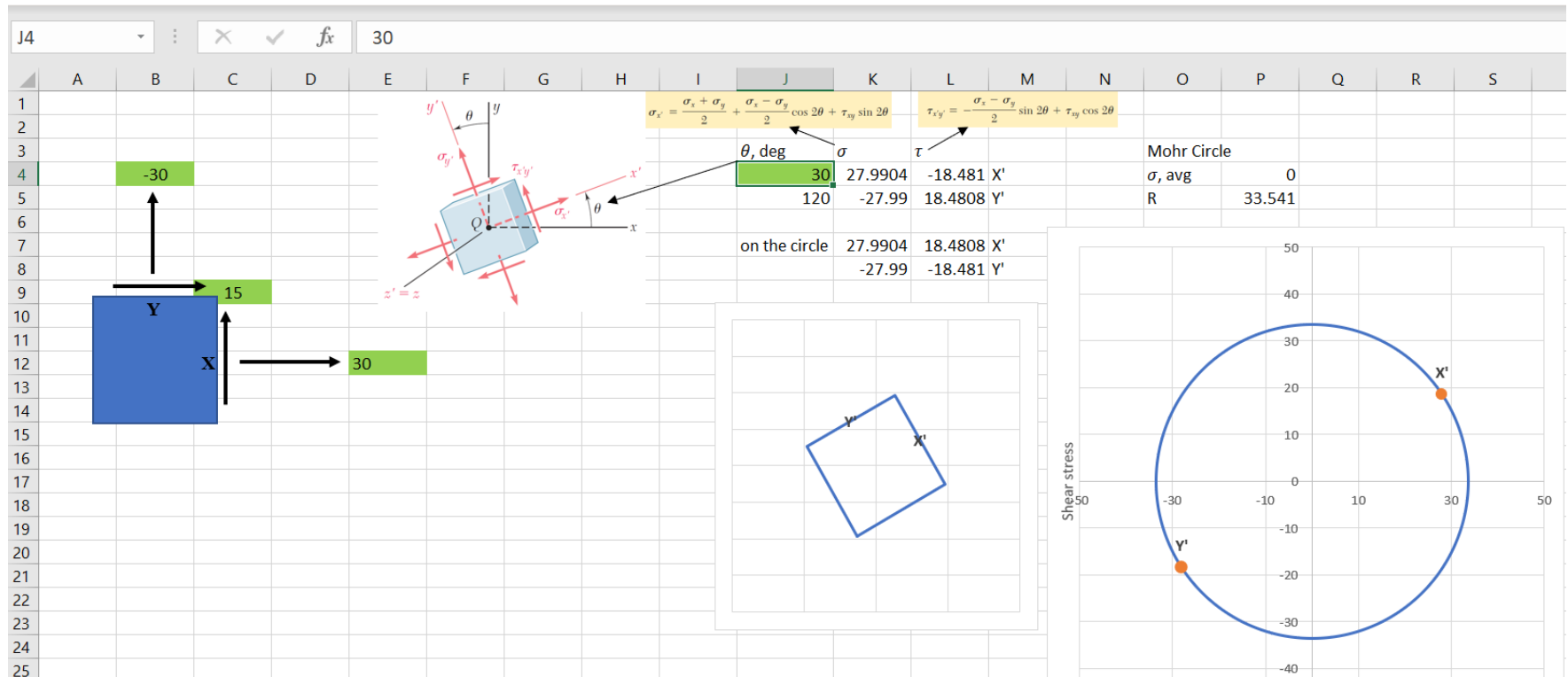
2 – Stress Transformation



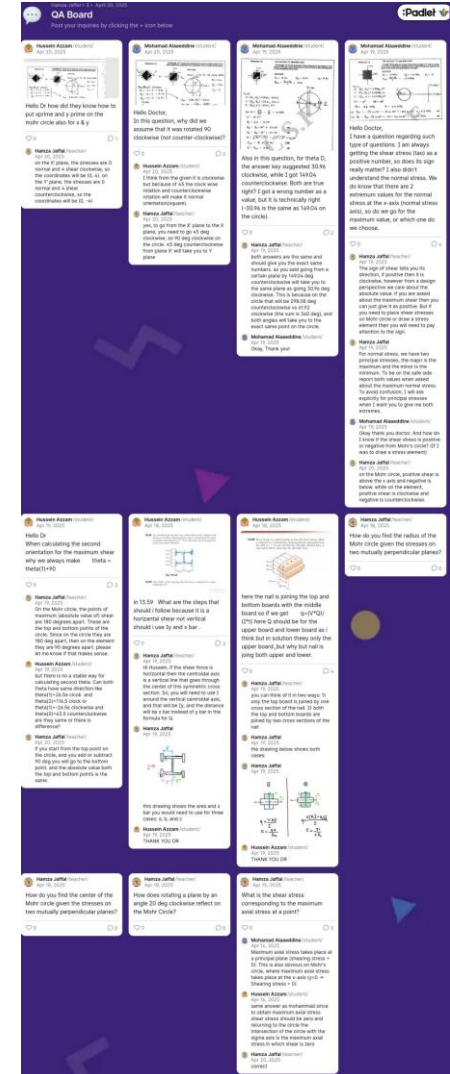
2 – Stress Transformation



2 – Stress Transformation



2 – Stress Transformation



The image shows a Padlet board titled "QA Board" for "Mechanical Stress". It contains a grid of discussion posts from students and a professor. The posts include:

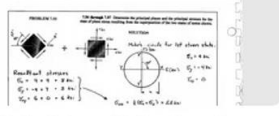
- Questions about Mohr's circle for a point under stress, such as "Mohr's circle for a point under stress".
- Answers explaining the relationship between principal stresses and Mohr's circle, including the formula $\sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$.
- Questions about the maximum shear stress and its orientation, such as "What is the shear stress corresponding to the maximum normal stress?".
- Answers explaining that the maximum shear stress is $\tau_{max} = \frac{\sigma_1 - \sigma_2}{2}$ and occurs on planes oriented at 45 degrees to the principal stress planes.
- Questions about the relationship between the angle of the principal stress and the angle of the maximum shear stress, such as "The angle of the principal stress is 30 degrees. What is the angle of the maximum shear stress?".
- Answers explaining that the angle of the maximum shear stress is 45 degrees from the principal stress planes.

Flipped Classroom

2 – Stress Transformation

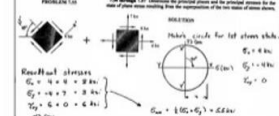


Hussein Azzam /student/
Apr 20, 2025



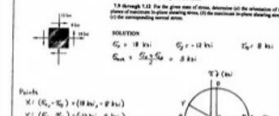
Hello Dr how did they know how to put xprime and y prime on the mohr circle also for x & y

Mohamad Alaeddine /student/
Apr 20, 2025



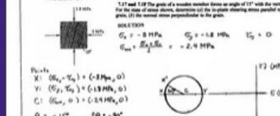
Hello Doctor,
In this question, why did we assume that it was rotated 90 clockwise (not counter-clockwise)?

Mohamad Alaeddine /student/
Apr 19, 2025



Also in this question, for theta D, the answer key suggested 30.96 clockwise, while I got 149.04 counterclockwise. Both are true right? I got a wrong number as a value, but it is technically right (-30.96 is the same as 149.04 on the circle).

Mohamad Alaeddine /student/
Apr 19, 2025



Hello Doctor,
I have a question regarding such type of questions. I am always getting the shear stress (tau) as a positive number, so does its sign really matter? I also didn't understand the normal stress. We do know that there are 2 extremum values for the normal stress at the x-axis (normal stress axis), so do we go for the maximum value, or which one do we choose.

Hamza Jaffal /teacher/
Apr 20, 2025

on the X' plane, the stresses are 0 normal and 4 shear clockwise, so the coordinates will be (0, 4), on the Y' plane, the stresses are 0 normal and 4 shear counterclockwise, so the coordinates will be (0, -4)

Hussein Azzam /student/
Apr 20, 2025

I think from the given it is clockwise but because of 45 the clock wise rotation and counterclockwise rotation will make it normal orientation (square).

Hamza Jaffal /teacher/
Apr 20, 2025

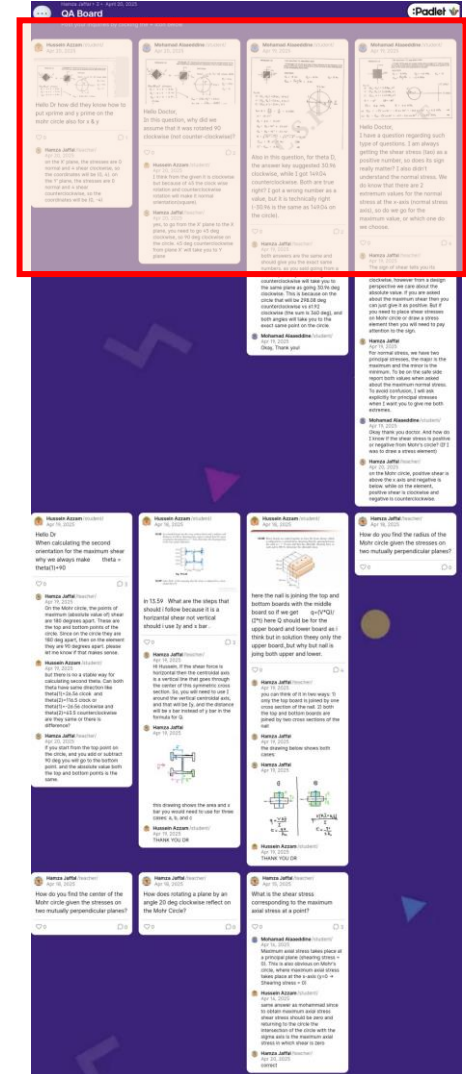
yes, to go from the X' plane to the X plane, you need to go 45 deg clockwise, so 90 deg clockwise from plane X' will take you to Y plane

Hamza Jaffal /teacher/
Apr 19, 2025

both answers are the same and should give you the exact same numbers. as you said doing from the circle.

Hamza Jaffal /teacher/
Apr 19, 2025

The sign of shear tells you its



QA Board

Padlet

Mohamad Alaeddine /student/
Apr 19, 2025

Hello Dr how did they know how to put xprime and y prime on the mohr circle also for x & y

Mohamad Alaeddine /student/
Apr 19, 2025

Hello Doctor,
In this question, why did we assume that it was rotated 90 clockwise (not counter-clockwise)?

Mohamad Alaeddine /student/
Apr 19, 2025

Also in this question, for theta D, the answer key suggested 30.96 clockwise, while I got 149.04 counterclockwise. Both are true right? I got a wrong number as a value, but it is technically right (-30.96 is the same as 149.04 on the circle).

Mohamad Alaeddine /student/
Apr 19, 2025

Hello Doctor,
I have a question regarding such type of questions. I am always getting the shear stress (tau) as a positive number, so does its sign really matter? I also didn't understand the normal stress. We do know that there are 2 extremum values for the normal stress at the x-axis (normal stress axis), so do we go for the maximum value, or which one do we choose.

Hussein Azzam /student/
Apr 20, 2025

on the X' plane, the stresses are 0 normal and 4 shear clockwise, so the coordinates will be (0, 4), on the Y' plane, the stresses are 0 normal and 4 shear counterclockwise, so the coordinates will be (0, -4)

Hussein Azzam /student/
Apr 20, 2025

I think from the given it is clockwise but because of 45 the clock wise rotation and counterclockwise rotation will make it normal orientation (square).

Hussein Azzam /student/
Apr 20, 2025

yes, to go from the X' plane to the X plane, you need to go 45 deg clockwise, so 90 deg clockwise from plane X' will take you to Y plane

Hussein Azzam /student/
Apr 19, 2025

both answers are the same and should give you the exact same numbers. as you said doing from the circle.

Hussein Azzam /student/
Apr 19, 2025

The sign of shear tells you its

2 – Stress Transformation



Hussein Azzam /student/
Apr 19, 2025
but there is no a stable way for calculating second theta. Can both have same direction like theta(1)=26.56 clock and theta(2)=116.56 clock or theta(1)=-26.56 counterclockwise and theta(2)=63.5 counterclockwise are they same or there is difference?

Hamza Jaffal /teacher/
Apr 20, 2025
if you start from the top point on the circle, and you add or subtract 90 deg you will go to the bottom point, and the absolute value both the top and bottom points is the same.

Apr 19, 2025
Hi Hussein, if the shear force is horizontal then the centroidal axis is a vertical line that goes through the center of this symmetric cross section. So, you will need to use I around the vertical centroidal axis, and that will be I_y , and the distance will be \bar{x} instead of \bar{y} in the formula for Q.

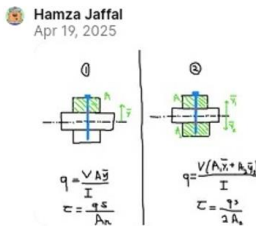


this drawing shows the area and \bar{x} bar you would need to use for three cases: a, b, and c

Hussein Azzam /student/
Apr 19, 2025
THANK YOU DR

Hamza Jaffal /teacher/
Apr 19, 2025
you can think of it in two ways: 1) only the top board is joined by one cross section of the nail. 2) both the top and bottom boards are joined by two cross sections of the nail

Hamza Jaffal
Apr 19, 2025
the drawing below shows both cases:



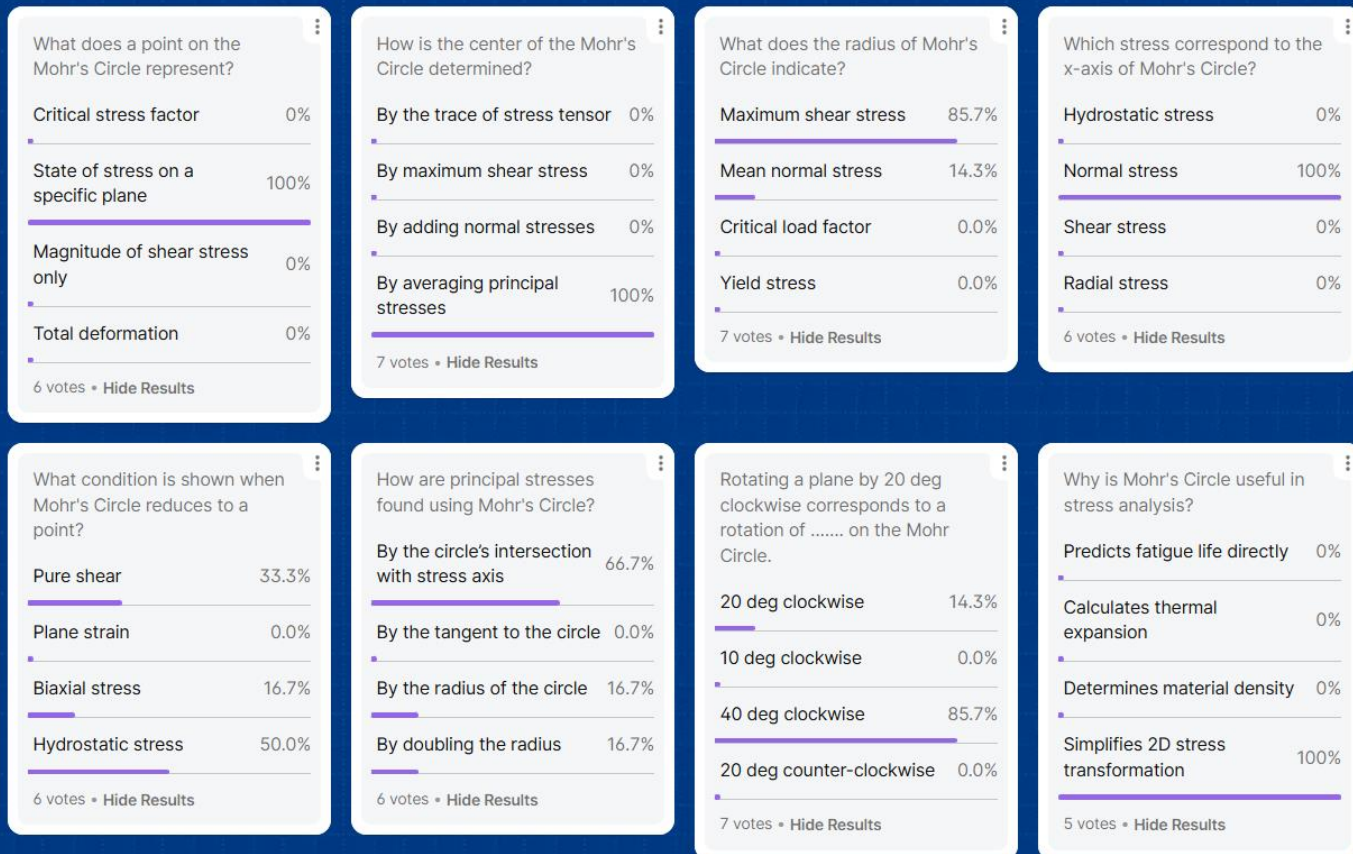
Hussein Azzam /student/
Apr 19, 2025
THANK YOU DR

2 – Stress Transformation



Assessment Polls: Mohr Circle

Advanced-level Learning Assessment Polls for Stress Transformation Topic in Higher Education



2 – Stress Transformation

CIE202: Mechanics of Materials

Spring 2025

Stress Transformation – Class Activity

Consider the two following loading conditions:

- 1) A rectangular beam subjected to pure negative bending moment:
Point of interest: a point at the top surface of the beam (the fibers with maximum tension)
- 2) A circular shaft subjected torsion:
Point of interest: a point on the outer surface of the beam

Divide yourselves into two groups (3 or 4 students per group) and do the following for both cases:

- a) On a piece of paper, draw the principal stress element clearly indicating its orientation.
- b) Draw that element on the rubber beam.
- c) Apply the load and inspect the strains.
- d) Did you guess the principal stress element correctly? Explain.

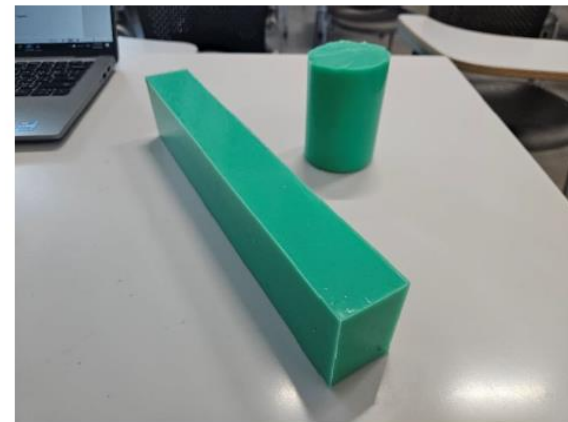


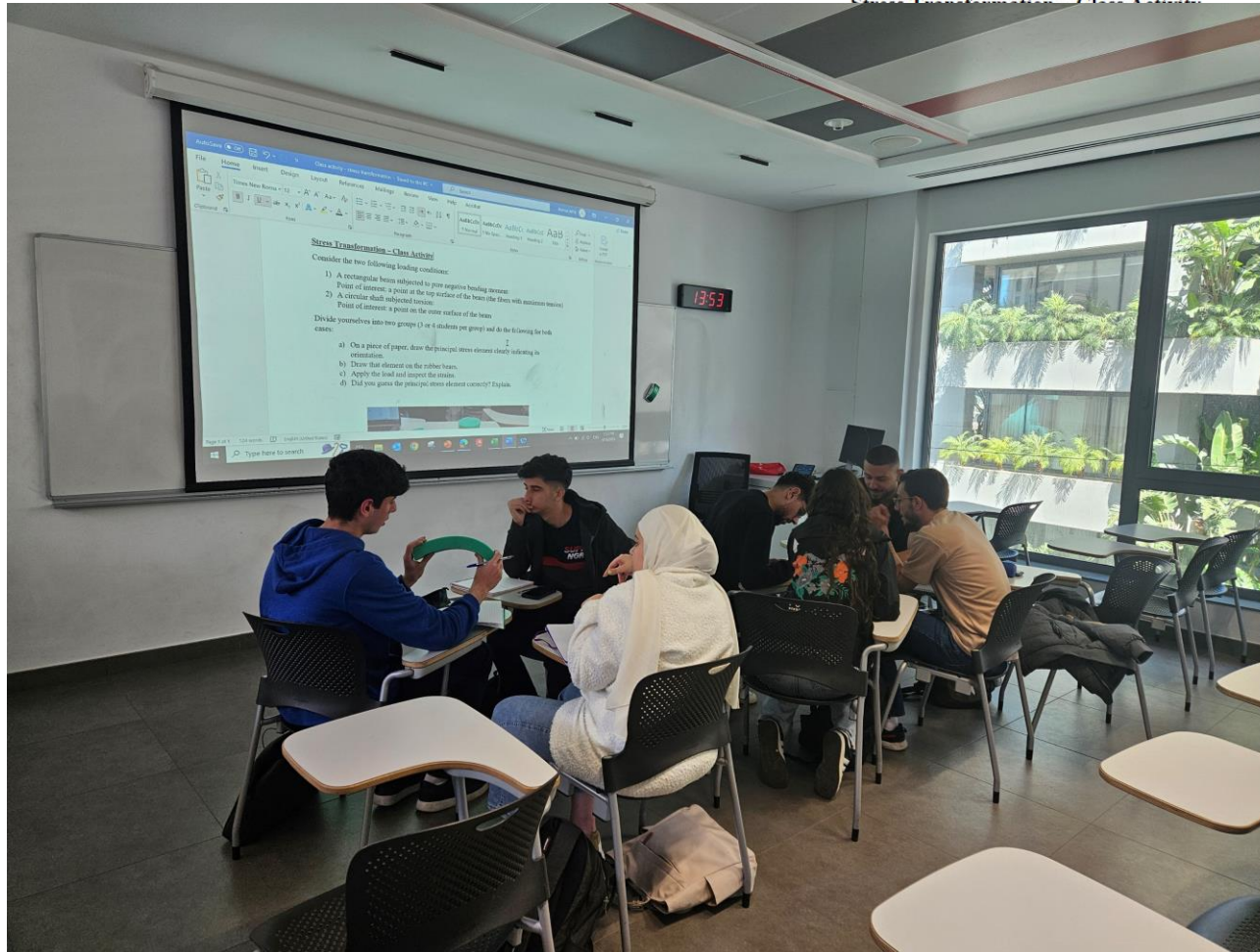
Figure 1: Silicone Rubber Beams used for the Class Activity

Flipped Classroom

2 – Stress Transformation

CIE202: Mechanics of Materials

Spring 2025



Stress Transformation - Class Activity

...tive bending moment:
...of the beam (the fibers with maximum tension)
...ce of the beam
...per group) and do the following for both
...stress element clearly indicating its
...ent correctly? Explain.



...s used for the Class Activity

Statistics!

