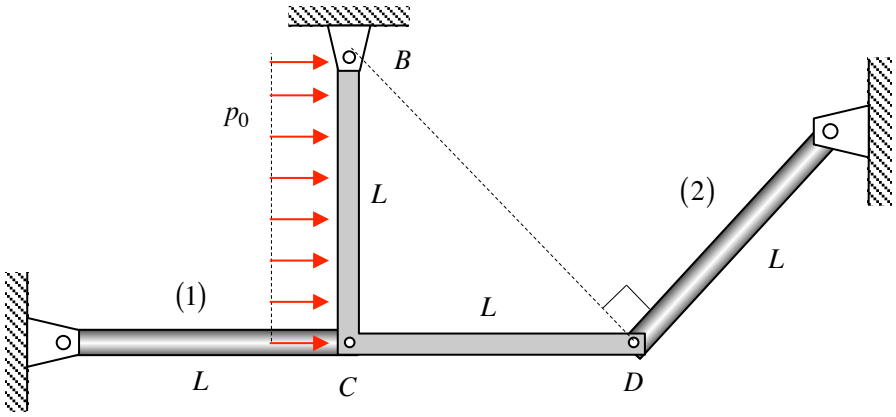
Sample exam problems

Attached here is a set of sample exam questions from past terms in the course. Please do not use these questions as an indication of which specific topics will appear on this term's midterm. These problems were chosen from past terms without regard to the specific questions that will appear on your exam.

Please use these questions to help you prepare for the midterm this summer. We will not be providing solutions for these questions, as we want you to use the questions to prepare under the exam-like situation of not knowing the answer, and you working through ways to check your work on your own, rather than looking at the answer to check your work. If you have questions regarding the solution of these problems, please check with your instructor and/or TA.

Please note that Weekly Joys has a good number of sample exam questions from past terms for which solutions are provided.

PROBLEM NO. 3 – 25 points max.



A rigid L-shaped bar BCD is pinned to ground at end B. Two, identical elastic bars (1) and (2) (each having a cross-sectional area of A and made up of a material with a Young's modulus of E) are connected between ground and pins C and D, respectively, with member (2) being perpendicular to line BD. A constant line load p_0 acts on arm BC of bar BCD. For this problem:

a) Using appropriate FBD(s), write down the equilibrium equation(s) relating the axial loads carried by members (1) and (2).

b) Write down the load/elongation equations for the members.

c) Write down the appropriate compatibility equations.

d) Reduce your results from a)-c) above to a set of <u>*two equations*</u> in terms of the loads carried by the two members. ***You are NOT asked to solve these equations.***

ME 323 – Mechanics of Materials
Examination #1
October 1st, 2020

PURDUE UNIVERSITY | Mechanical Engineering

Name (Print) _____
(Last) **(First)**

PROBLEM # 1 (25 points)

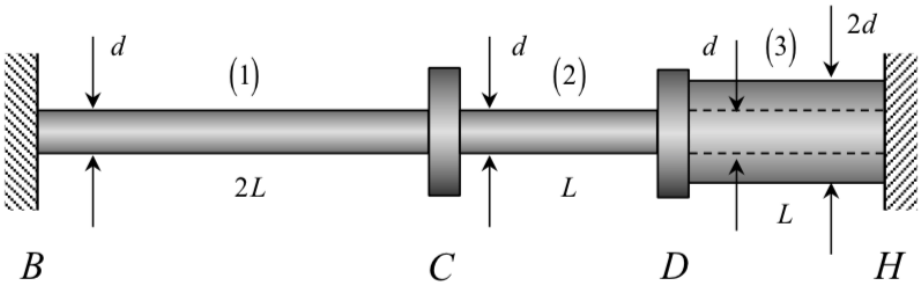
A rod is made up of elastic members (1), (2) and (3), with the material makeup of each member having a Young's modulus of E and a coefficient of thermal expansion of α. Members (1), (2) and (3) have lengths of $2L$, L and L, respectively. Members (1) and (2) have solid cross-sections with a diameter of d, whereas member (3) has a tubular cross-section with inner and outer diameters of d and $2d$, respectively. With the members being initially unstressed, the temperatures of (1) and (2) are increased by amounts of $2\Delta T$ and ΔT, respectively, while the temperature of (3) is held constant.

As a result of the temperature changes described above:

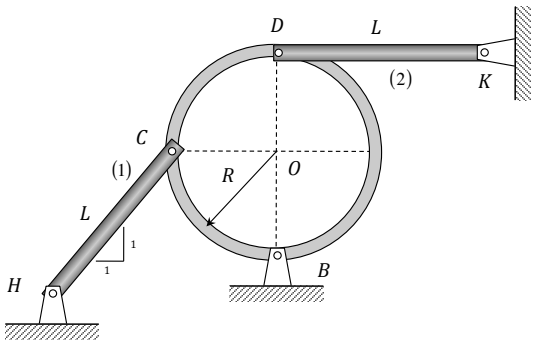
a) Determine the axial load (force) carried by each member. State whether each member is experiencing a compressive or tensile load.

b) Determine the axial strain in each member. Include an appropriate sign with each strain.

Leave your answers in terms of, at most, E, α, L, d and ΔT.



ME 323 Final Examination ***Name _____***
August 4, 2021



PROBLEM NO. 3 – 20 points max.

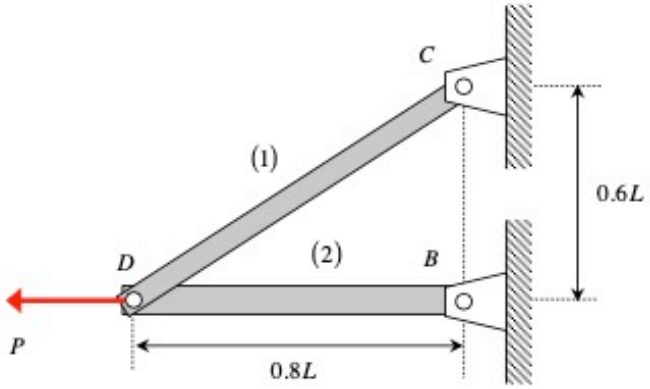
Identical elastic members (1) and (2) (each having a length of L, cross-sectional area A and made up of a material having a Young's modulus E and coefficient of thermal expansion of α) are attached to a thin rigid ring of radius R. Member (1) is at a 45° angle with respect to the horizontal, and member (2) is horizontal. The temperature of member (1) is increased by an amount of ΔT , while the temperature of (2) is held constant. It is desired to find the axial stress in each member as a result of the temperature increase of member (1). To this end:

1. ***Equilibrium***: Draw a free body diagram of the ring. Write down the appropriate equilibrium equation(s) for the ring.

2. ***Load/deformation equations***: Write down the load/deformation equations for members (1) and (2).

ME 323 Examination # 1 **Name** _____

July 5, 2017



PROBLEM NO. 1 – 25 points max.

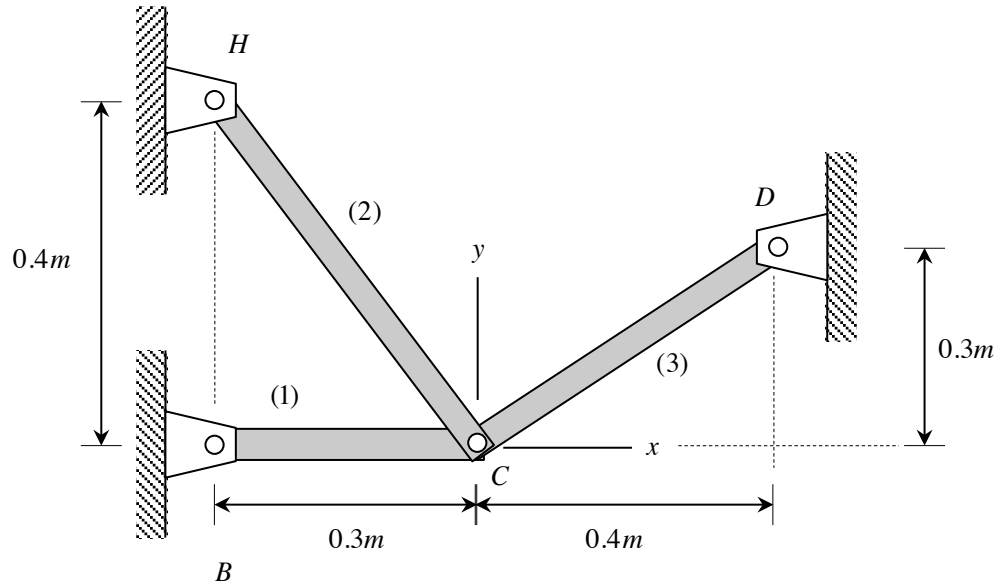
A truss is made up of members (1) and (2), as shown above, with the cross-sectional areas of (1) and (2) being A and 2A, respectively, and with D being on the same horizontal plane as joint B. Both members are made up of a material with a Young's modulus of E. A horizontal load P is applied at joint D of the truss. In addition, the temperatures of members (1) and (2) are increased by amounts of ΔT and $2\Delta T$, respectively. As a result of the applied load and the temperature increases:

a) What is the stress in each member of the truss? What is the strain in each member of the truss?

b) What are the horizontal and vertical components of displacement of joint D?

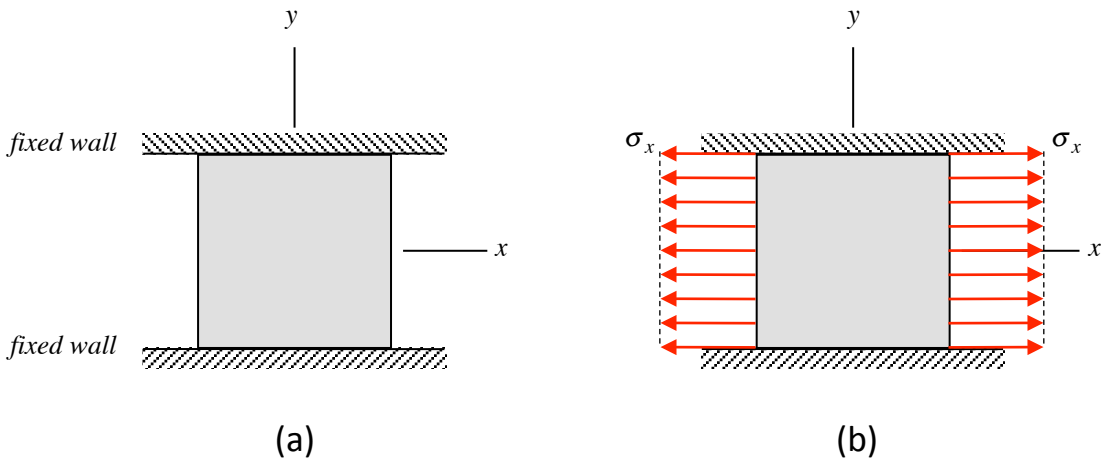
Clearly label the four steps of the process in your solution.

PROBLEM NO. 4 - <u>PART A</u> – 5 points max.



The truss shown above is loaded at joint C in such a way that the horizontal and vertical components of displacement of joint C are $\left(u_C, v_C\right) = \left(2, 6\right)\, mm$. Determine the elongation of member (2) of the truss.

PROBLEM NO. 4 - <u>PART D</u> – 6 points max.



(a) (b)

A square homogeneous block made up of a material with a Poisson's ratio of $\nu = 0.3$ is placed between two smooth, rigid walls. Initially, the temperature of the block in Figure (a) above is increased by an amount that produces a compressive normal stress of $\sigma_y = -20\ ksi$. After that, the block is given an additional tensile stress component σ_x, as shown in Figure (b) above, with this stress, in turn, reducing the y-component of stress to $\sigma_y = -5\ ksi$. Determine the value of σ_x.

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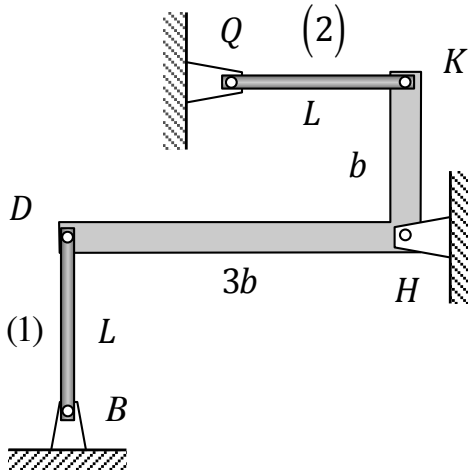
Part 4B

The rigid, L-shaped bar DHK is pinned to ground at H, and identical elastic links (1) and (2) (having the same Young's modulus *E*, cross-sectional area *A*, length *L* and coefficient of thermal expansion α, are connected between D and B, and between Q and K, respectively. Links (1) and (2) are vertical and horizontal, respectively. The temperature of link (2) is raised by an amount of ΔT, whereas the temperature of link (1) is held constant. Let ε_1 and ε_2 be the axial strains in (1) and (2), respectively, and σ_1 and σ_2 be the corresponding axial stresses in the links.



Circle the correct responses below:

2 points:

a) $|\sigma_1| > |\sigma_2|$

b) $|\sigma_1| = |\sigma_2|$

c) $|\sigma_1| < |\sigma_2|$

2 points:

a) σ_1 and ε_1 have the *same* signs

b) σ_1 and ε_1 are both *zero*

c) σ_1 and ε_1 have *opposite* signs

2 points:

a) σ_2 and ε_2 have the *same* signs

b) σ_2 and ε_2 are both *zero*

c) σ_2 and ε_2 have *opposite* signs

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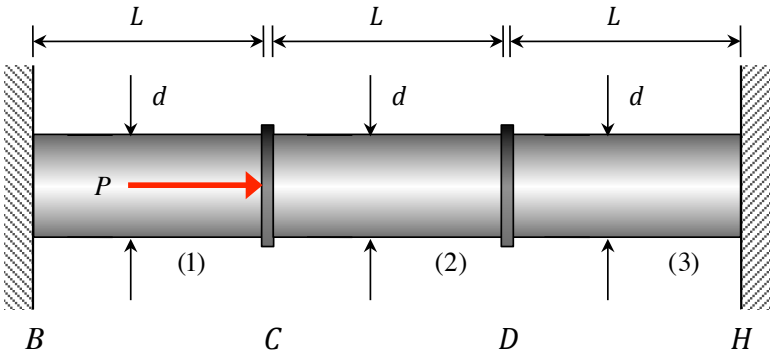
Part 4C

A rod is made up of solid, circular cross-sectioned elements (1) and (2) and (3), with (1) and (2) joined with a rigid connector C, and (2) and (3) joined by rigid connector D. All three elements are made of the same type of steel, having a Young's modulus of E_{steel}. A load P acts in the axial direction on connector C. Let F_1, F_2 and F_3 be the axial load (force) carried by, and σ_1, σ_2 and σ_3 be the axial stresses in, elements (1), (2) and (3), respectively.



Circle the correct responses below:

2 points:

a) $|F_2| > |F_3|$

b) $|F_2| = |F_3|$

c) $|F_2| < |F_3|$

2 points:

a) $|F_1| > |F_2|$

b) $|F_1| = |F_2|$

c) $|F_1| < |F_2|$

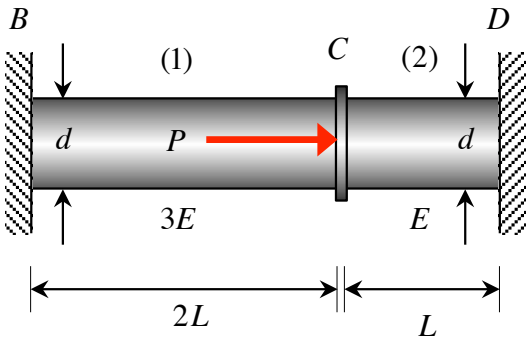
2 points: Suppose the material of element (3) is changed to aluminum having a Young's modulus $E_{aluminum}$, where $E_{steel} > E_{aluminum}$. With this change in material:

a) $|\sigma_1|$ is increased

b) $|\sigma_1|$ is unchanged

c) $|\sigma_1|$ is decreased

PROBLEM NO. 4 - <u>PART B</u> – 3 points max.



A rod is made up of elements (1) and (2) joined together by the rigid connector at D, with the elements having solid circular cross sections. The materials of elements (1) and (2) have Young's moduli if $E_1 = 3E$ and $E_2 = E$, respectively. As a result of the axial load P applied at connector C, members (1) and (2) carry loads of F_1 and F_2, respectively. Circle the item below that most accurately describes the relative sizes of the load magnitudes in the two elements:

a) $|F_1| > |F_2|$

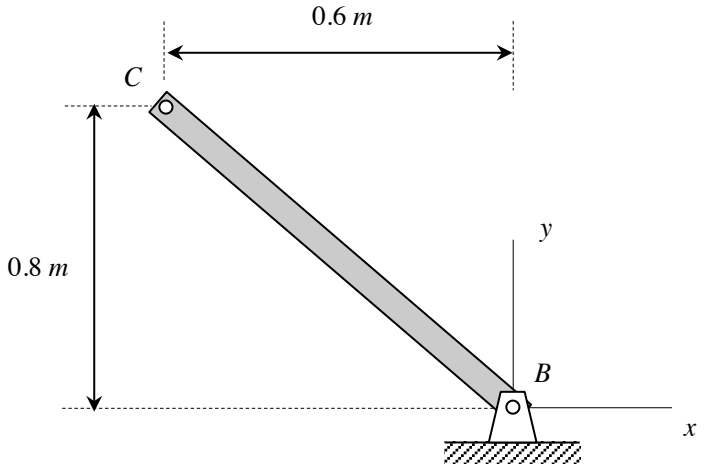
b) $|F_1| = |F_2|$

c) $|F_1| < |F_2|$

d) More information is needed in order to answer this question.

You are NOT asked to provide an explanation for your answer.

PROBLEM NO. 4 - <u>PART A</u> – 5 points max.



Truss member BC is known to be in an orientation shown above. As a result of loads being applied to the truss (neither the loading nor the other members of the truss are shown in figure), joint C is moved *16 mm to the RIGHT* and *12 mm UP*. For this motion:

a) What is the total displacement of joint C?

b) What is the elongation of member BC?

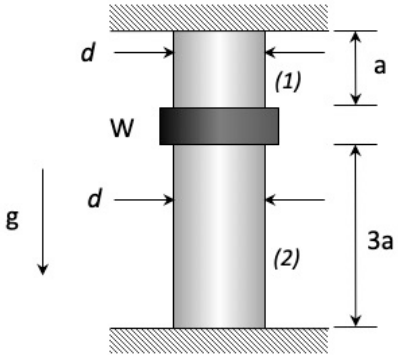
ME 323: Mechanics of Materials ***Name*** _____

Examination 1 - Summer 2023

Problem No. 4

PART B – 5 points

A rigid plate of weight W is rigidly attached to two sections, (1) and (2), that form a vertical column, with the lengths of these sections being *a* and 3a, respectively. The two column sections are made of the same material and have the same diameter *d*. The column sections are rigidly attached to an upper and lower surfaces. The weight of the column sections can be considered to be negligible compared to the weight of the plate. Let $|F_1|$ and $|F_2|$ represent the magnitudes of the loads carried by sections (1), and (2), respectively. Choose the correct response below:



a) $|F_1| > |F_2|$
b) $|F_1| = |F_2|$
c) $|F_1| < |F_2|$
d) More information is required to answer this question.

Provide a justification for your selection.