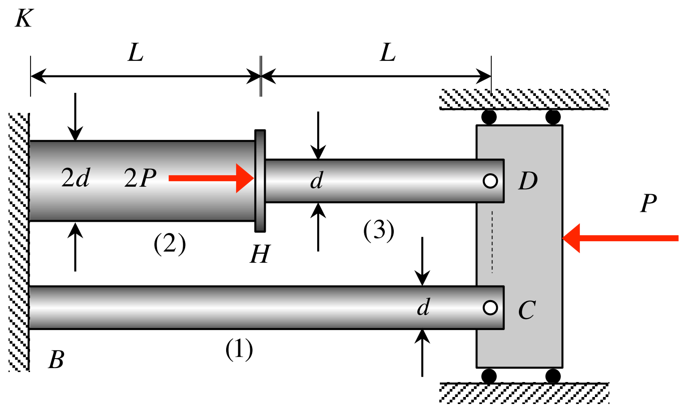
ME 323 Examination #1 **Name** ________________________________
July 1, 2015

PROBLEM NO. 1 – 25 points max.



Rods (1) and (3) are attached to a moveable support, as shown above. Rod (3) is axially attached to rod (2) with a thin, rigid connector H. Rods (1) and (2) are attached to a fixed wall. Forces P and 2P act on the moveable support and on connector H, respectively. All rods have a solid, circular cross section and are made of a material having a Young's modulus of E. It is desired to determine the load carried by rods (1), (2) and (3).

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

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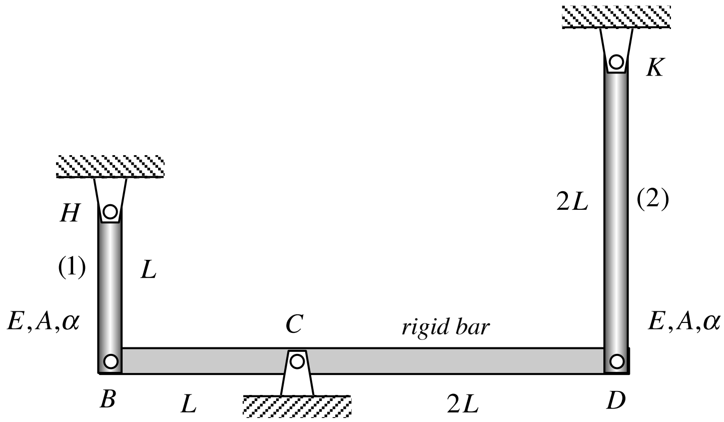
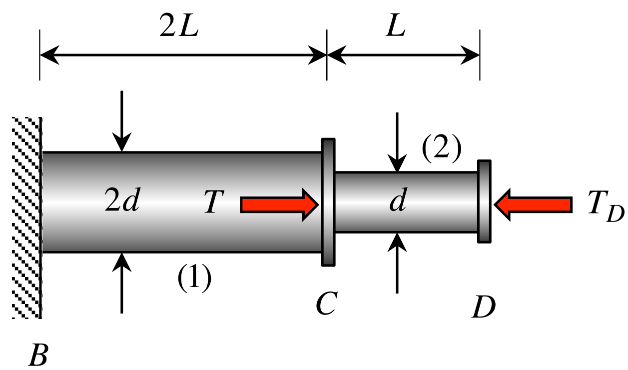
PROBLEM NO. 2 – 25 points max.



A horizontal rigid bar BD is pinned to ground at C. Connected to ends B and D are vertical rods (1) and (2). The two rods are made of the same material (having a Young's modulus of E and thermal expansion coefficient of $a = \alpha$) and have the same cross-sectional area A. The temperature of rod (2) is increased by a temperature of ΔT while the temperature of rod (1) is held constant. It is desired to determine the load carried by rods (1) and (2).

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

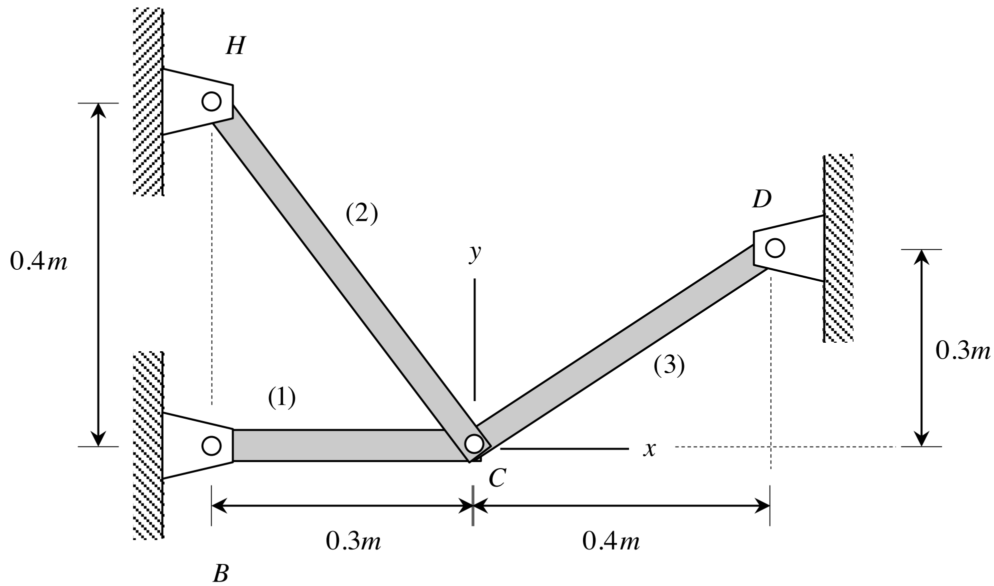
PROBLEM NO. 3 – 30 points max.



A shaft is made up of members (1) and (2), with the members joined by the thin rigid connector C. Each member has a solid, circular cross section, and is made up of a material having a shear modulus of G. A torque T is applied to the rigid connector C, as shown above. A second torque T_D is applied to a rigid connector at end D of the shaft. Determine the value of the torque T_D for which the rotation of connector D is zero.

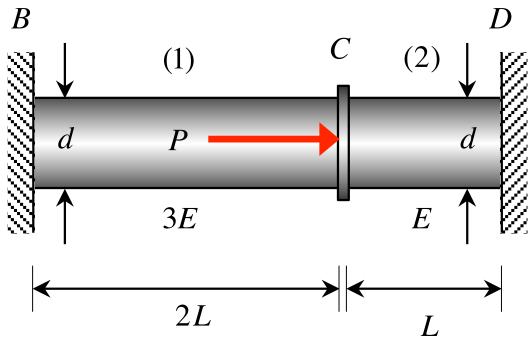
Clearly label the four steps of the process in your solution.

PROBLEM NO. 4 - PART A – 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 $(u_C, v_C) = (2,6)\ mm$. Determine the elongation of member (2) of the truss.

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) $|F_1| > |F_2|$

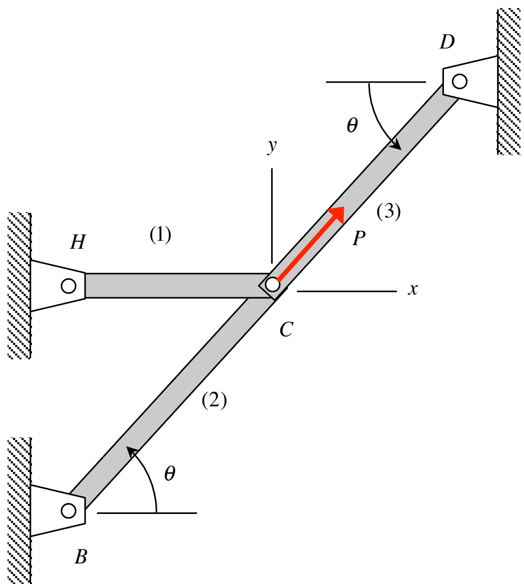
b) $|F_1| = |F_2|$

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 - PART C – 6 points max.



In the truss shown above, member (1) is horizontal, with members (2) and (3) aligned and at an angle of θ with respect to the horizontal. A load P is applied to joint C in a direction that is aligned with members (2) and (3). Simultaneously, the temperature of member (2) is *increased*, with the temperatures of the remaining members being held constant. Let e_1 be the elongation of member (1), and $\left(u_C, v_C\right)$ being the x- and y-components of displacement of joint C due to the load P.

For this loading on the truss, the axial stress in member (1) is (circle the correct response):

a) compressive.

b) tensile.

c) zero.

HINT: consider an FBD of joint C.

Also, for this loading the *displacement* of joint C is (circle the correct response):

a) up and to the right ($u_C > 0$ and $v_C > 0$)

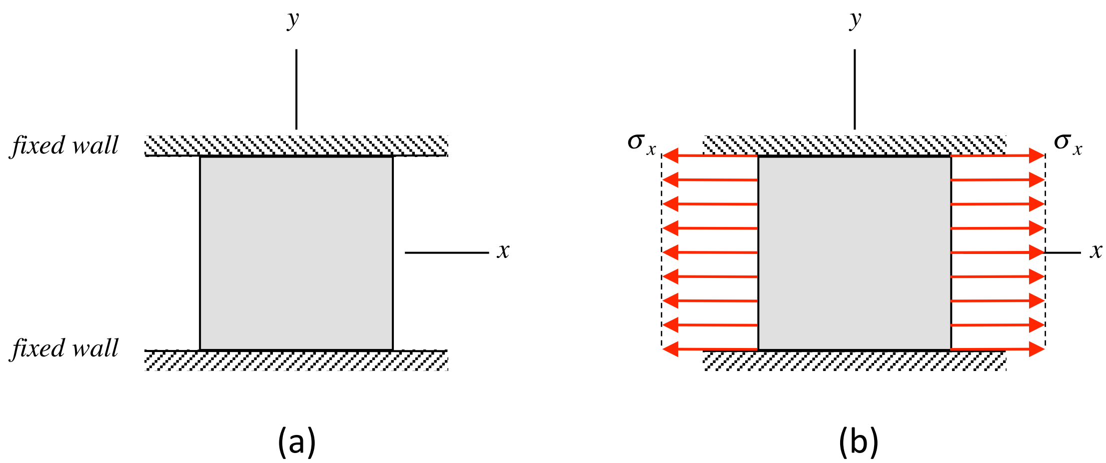
b) directly to the right ($u_C > 0$ and $v_C = 0$)

c) directly up ($u_C = 0$ and $v_C > 0$)

d) zero ($u_C = 0$ and $v_C = 0$)

You are NOT asked to provide explanations for your answers.

PROBLEM NO. 4 - PART D – 6 points max.



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.