ROSE-HULMAN
INSTITUTE OF TECHNOLOGY

Name _____

Circle section:

03 [1 pm, Thom] **04** [2 pm, Thom]
05 [1 pm, Bernal] **06** [2 pm, Bernal]

EM121 – Statics and Mechanics of Materials I

Exam 2

Jan 22, 2024

Rules:

- Closed book/notes exam.
- Only instructor-provided help sheet allowed.
- Calculators only. No Maple, Excel, MATLAB, etc.

Instructions:

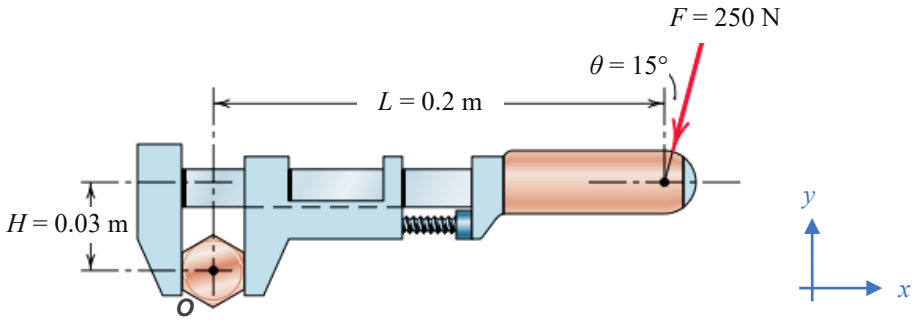
- Show your work to maximize the credit! But you don't have to state Given: and Find:
- For problems involving equilibrium draw a complete and correct FBD first and then set up the equations.
- Helpful hint: Work in symbols for as long as you can, crunching numbers last.
- Numbers and results that appear out of nowhere are unjustified and will not receive full credit.
- If I can't follow what you're doing, I will count it wrong. Use words and phrases as needed.

Problem 1	_____/ 20
Problem 2	_____/ 40
Problem 3	_____/ 40
Total	_____/100

PROBLEM 1 [20 points]

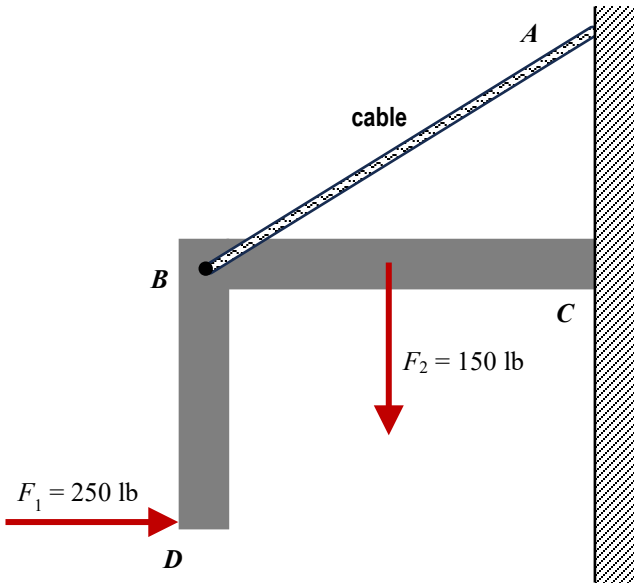
Note: Each part of this problem will be graded on the following scale: 50% for committing one mistake of any kind, and 0% for multiple mistakes of any kind. Be sure to follow directions and provide all requested information.

(a) [5 pts] Calculate the moment of the F = 250 N force (exerted on the wrench handle) about point O (the center of the bolt head). Report your answer in Cartesian vector form.

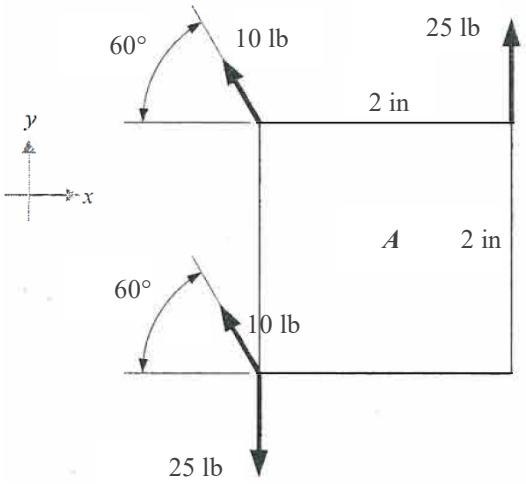


(b) [5 pts] An aluminum rod has a cross-sectional area of A = 240 mm² and is loaded axially in tension. The yield strength of the aluminum is σ_y = 270 MPa. Using a factor of safety of FOS = 2, determine the maximum load that may be applied to the rod before yielding.

(c) [6 pts] Draw a free-body diagram of the L-bracket *BCD*. The weights of the bracket and the cable are negligible.

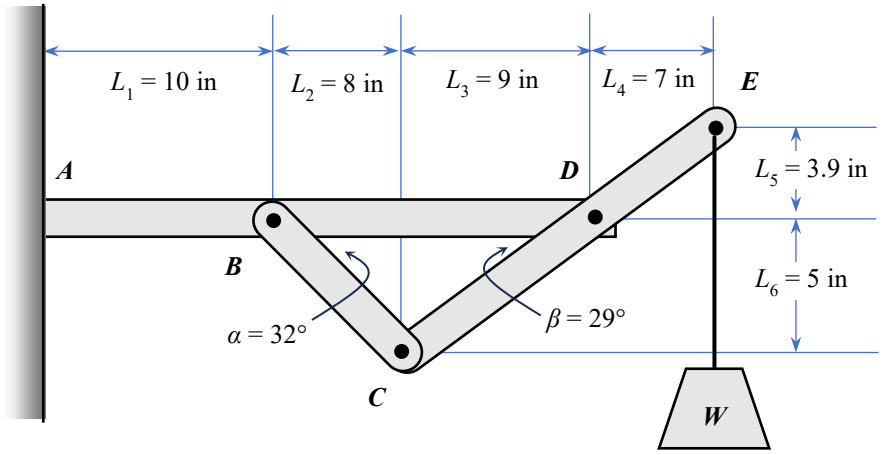


(d) [4 pts] Square plate *A*, with 2-inch sides, has four forces exerted on it as shown. Calculate the moment(s) due to only those forces that form a couple. Report the moment(s) in Cartesian vector form in units of in-lb.



PROBLEM 2 [40 points]

The structure shown in the figure is constructed of three massless members connected with frictionless pins at *B*, *C*, and *D*. The bar *ABD* is built into the wall at *A*. The weight *W* is suspended from a massless rope at point *E*. Tne structure is in equilibrium. The weight *W* is known.



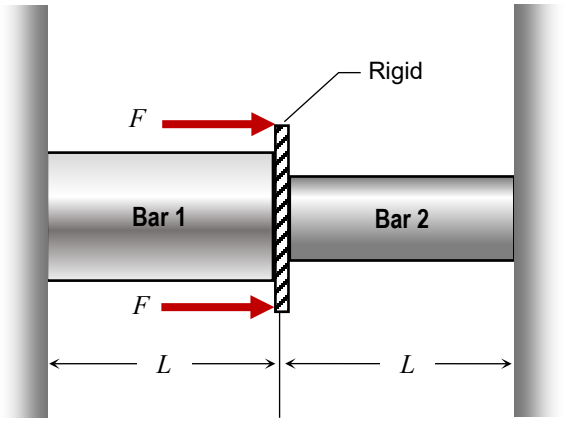
Known: All *L*s, *W*, α, β

(a) Set up, *but do not solve*, a system of scalar equations necessary to find the reaction(s) at point *A*. Document your solution according to the guidelines established in class.

(b) Set up, *but do not solve*, a system of scalar equations necessary to find the reactions on bar *ABD* at points *B* and *D*. Document your solution according to the guidelines established in class.

PROBLEM 3 [40 points]

Two bars of identical length L are connected through a rigid plate in the configuration shown. Bar 1 has elastic modulus E_1 and cross-sectional area A_1. Bar 2 has elastic modulus E_2 and cross-sectional area A_2. The assembly is placed between two rigid walls in a stress-free state, perfectly filling the gap when unloaded. The plate is then symmetrically and axially loaded as shown (with F known). Simultaneously, the temperature of Bar 2 is increased by ΔT. Bar 2's coefficient of thermal expansion is α_2.



Known: L, E_1, E_2, A_1, A_2, F, α_2, ΔT

Assuming both bars to be massless, set up the scalar equations that are needed to determine the resulting normal stress in Bar 1 after the loading and temperature change. Do not solve the equations but be sure to number the equations and list the unknowns (see the next page).

Equations	Unknowns