**Student ID**______________________________

**Department of Mechanical Engineering**
**Michigan State University**
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# Ph.D. Qualifying Exam in Solid Mechanics

- **Open One Book**
- **Answer all questions. All questions have the same weight.**

Exam prepared by

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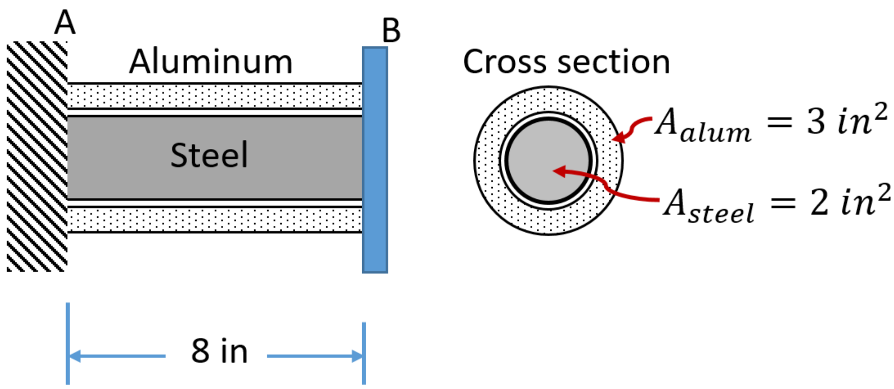
**Problem 1**

A hollow aluminum tube is surrounding a solid steel cylinder. The tube and cylinder are fixed to the wall at A. They are both welded to a rigid plate at B. The plate can move freely. When the temperature is 45°F there are no internal stresses.




a) Find the reaction $R_A$ for the steel bar when the temperature reaches 145°F.

b) Find the internal stress in the steel bar when the temperature reaches 145°F.

Steel: Young's Modulus = $30x10^6\ psi$

Coefficient of thermal expansion = $6.5\ x10^{-6}\ 1/°F$

Aluminum: Young's Modulus = $10x10^6\ psi$

Coefficient of thermal expansion = $13\ x10^{-6}\ 1/°F$

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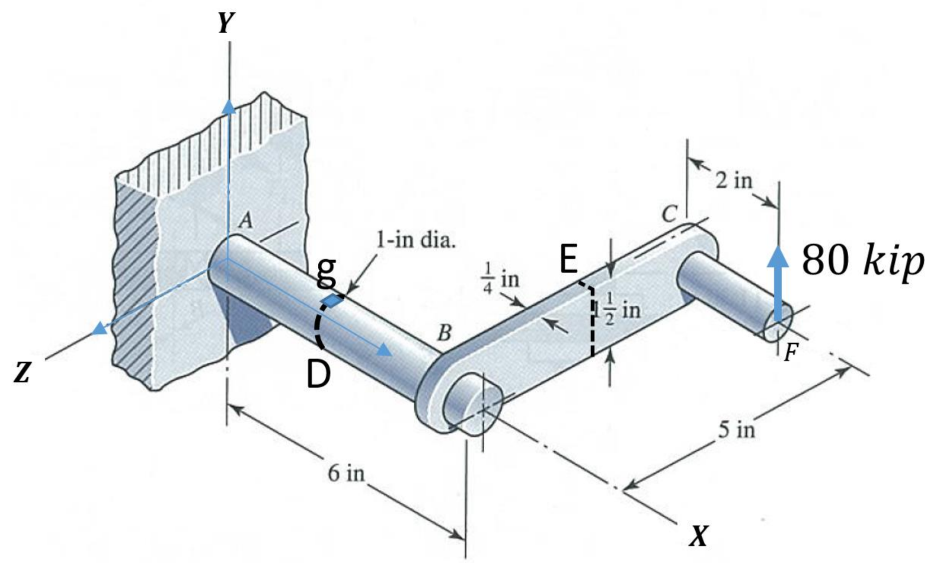
**Problem 2**

The 3D structure shown in the Figure has a cross section of diameter 1 inch and is loaded with to forces shown. Find the following values.

a) Calculate the internal forces and moments at cut D (halfway between A and B).

b) Calculate the complete stress state at point g.

c) Draw the stress element for the stress at the point g.



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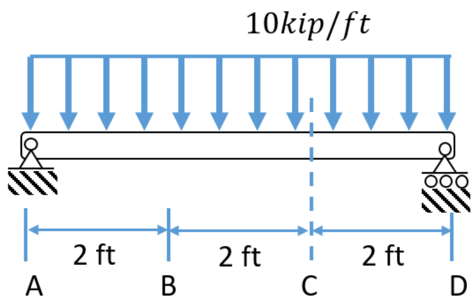
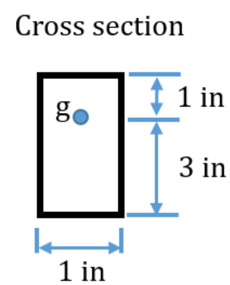
**Problem 3**

The beam shown has a 10 kip/ft load across the whole beam. Find the 2D state of stress at point g, shown on the cross section at cut C.



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**Problem 4**

*Using the cut and integration method*, find the piecewise function $y(x)$ for the deflection of the beam. What is the deflection at the end of the beam?

For this problem, use $EI = 5E3\ [m^4Pa]$