Mansoura University
Faculty of Engineering
Prod. Eng. & Mech. Design Dept.

Level 100 – Biomedical Eng. Dept.
PDE181 – Strength of Materials
20 Marks – 1 Hour

Mid Term Exam

Question [1]:   (5 Marks)

**Choose the correct answer for the following sentences from the bracket:** (o. S each)

[Stress Concentration – Stress – Strain – Normal – Shear – Safety Factor – Material – No – Force – Elasticity Modulus – Poisson Ratio – Statically Indeterminate – Equilibrium – Area]

- The difference between stress analysis and design is that stress analysis is used to determine _Stress_ , while design is used to determine either _Force_ , _Area_ or _Material_ .
- Bearing stress is a type of _Normal_ stresses.
- The ratio of material strength to the allowable stress is known as _Safety factor_
- For a structure, if fundamental equations of statics are not sufficient to determine all the reactive forces at the supports, the structure is said to be _Statically Indeterminate_
- If a bar, fixed from one end only, is subjected to a temperature rise of 50°, then it is subjected to _No_ stress.
- _poisson ratio_ is defined as the ratio of the lateral strain to the axial strain.
- The presence of holes or fillets in loaded parts leads to _Stress Concentration_ near the holes or fillets.

Question [2]:   (5 Marks)

Complete the following sentences with respect to the figure shown: (o.5 each)

- Pipe AB is subjected to _Compressive_ stress of value _8571.43_ psi M̶P̶a̶ which is accompanied by _decrease_ (increase/decrease) of its length with a magnitude of _0.041_ in.
- Rod BC is subjected to _tensile_ stress of value _50000_ psi M̶P̶a̶ which is accompanied by _increase_ (increase/decrease) of its length with a magnitude of _0.145_ in.
- The resulting deflection of point C is going to be _downward_ (upward/downward) with a value of _0.186_ in.

4 ft

3 ft

B

E=10.1×10⁶psi
A=1.75 in²

A

E=29×10⁶psi
A=0.3 in²

C

15-kip
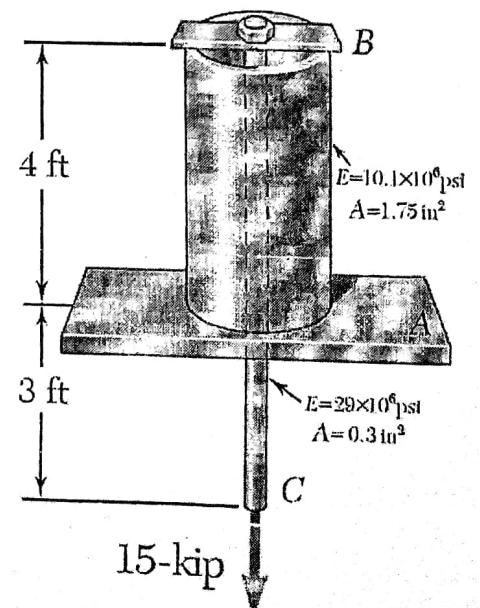
Question [3]: (10 Marks)

The rigid bar AD is supported by two steel wires of 1/16in diameter (E=29X10⁶psi) and a pin and bracket at D. Knowing that the wires were initially taut, determine (a) the additional tension in each wire when a 120lb load P is applied at B, (b) the corresponding deflection of point B.

- **Given:** $d_{wire} = \frac{1}{16}$ in $\qquad E_{st} = 29 \times 10^6$ psi
$$P = 120 \text{ lb}$$

- **Req.:** F_{AE}, F_{CF}, δ_B

- **Sol.:**

$\rightarrow \Sigma M_D = 0: \quad 120 \times 16 = F_{AE} \times 24 + F_{CF} \times 8 \rightarrow ①$

$\rightarrow \Sigma F_y = 0: \quad 120 = F_{AE} + F_{CF} + D_y \quad ②$

$\rightarrow \Sigma M_x = 0: \quad D_x = 0$

∵ we have 2 eqns & 3 unknowns
∴ problem is statically indeterminate ①

$\rightarrow \dfrac{\delta_{AE}}{24} = \dfrac{\delta_B}{16} = \dfrac{\delta_{CF}}{8} \quad ①$

@ $\dfrac{\delta_{AE}}{24} = \dfrac{\delta_{CF}}{8} \Rightarrow \dfrac{F_{AE} \cdot L_{AE}}{A_{wire} \cdot E_{st}} = \dfrac{24}{8} \times \dfrac{F_{CF} \times L_{CF}}{A_{wire} \times E_{st}}$

∴ $F_{AE} \times 15 = \dfrac{24}{8} \times F_{CF} \times 8$

∴ $F_{AE} = 1.6 \, F_{CF} \longrightarrow ② ①$

Solving ① & ②

∴ $\boxed{F_{AE} = 66.2 \text{ lb}} \qquad \boxed{F_{CF} = 41.38 \text{ lb}} \quad ①$

@ $\dfrac{\delta_{AE}}{24} = \dfrac{\delta_B}{16} \Rightarrow \delta_B = \dfrac{16}{24} \times \dfrac{F_{AE} \cdot L_{AE}}{A_{wire} \cdot E_{st}}$

∴ $\delta_B = \dfrac{16}{24} \times \left(\dfrac{66.2 \times 15}{\frac{\pi}{4} \times \left(\frac{1}{16}\right)^2 \times 29 \times 10^6} \right) \Rightarrow \boxed{\delta_B = 7.44 \times 10^{-3} \text{ in} \downarrow} \quad ②$