Daffodil International University

B. Sc. in Civil Engineering

Midterm Examination, Spring - 2026

Course Code: CE 213 | Course Title: Mechanics of Solids II

Section: A, B, C | Level-Term: 2-2 | Teacher's Initial: SAR, JD

Full Marks: 25 | Date: February 22, 2026 | Time: 1.5 Hours

Note: Answer all the questions. Assume any reasonable value if not provided. Right hand margin indicates full marks.

1. a) Prove that, in case of plane stress the sum of the normal stresses exerted on a cubic element of material is independent of the orientation of that element. *[CO1, C5]* [04]

$$\sigma_x' + \sigma_y' = \sigma_x + \sigma_y$$

b) The current state of element with plane stress with respect to xy- axes can be shown in the Fig 2. Determine the following- [06]

i. The state of stress with respect to x'y' axes,

ii. The principal stresses and principal planes,

iii. The maximum in plane shear stress.

Then show the stress values on properly oriented stress blocks. *[CO1, C5]*

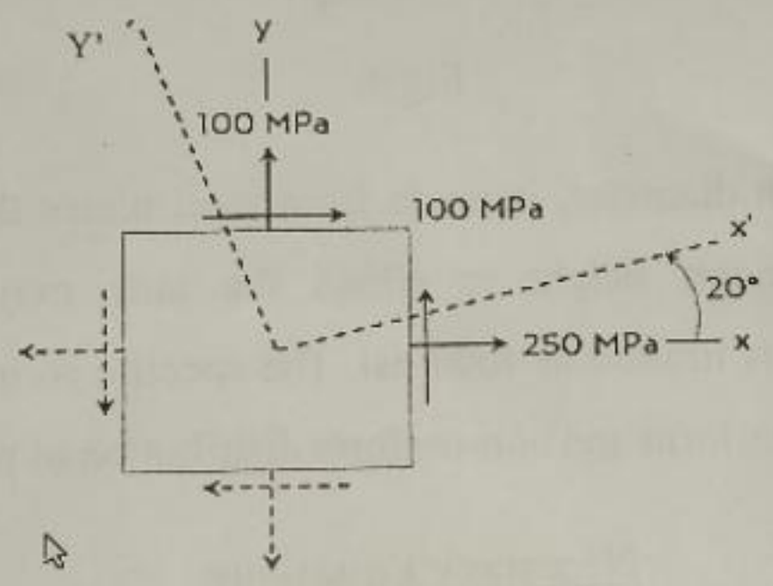

Fig 2.

c) The bent bar shown in Fig 3. Is 200 mm square. Determine the normal stresses at A and B. *[CO1, C5]* [05]

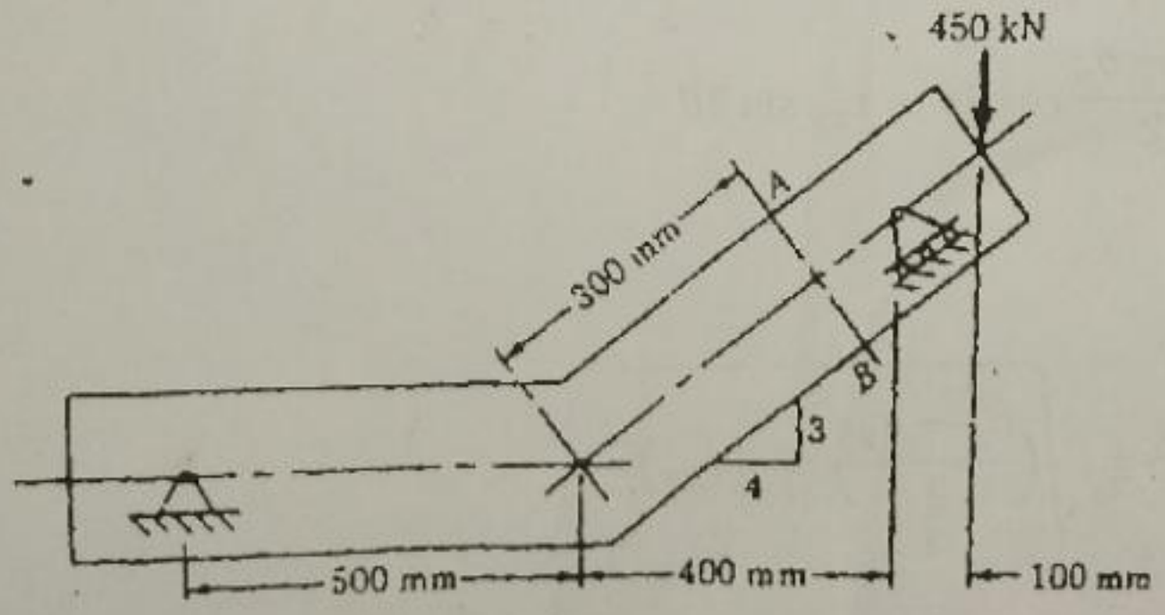

Fig 3.

d) Determine the flexural stress at each corner point of the column as shown in Fig 4. [05]
[CO1, C5]

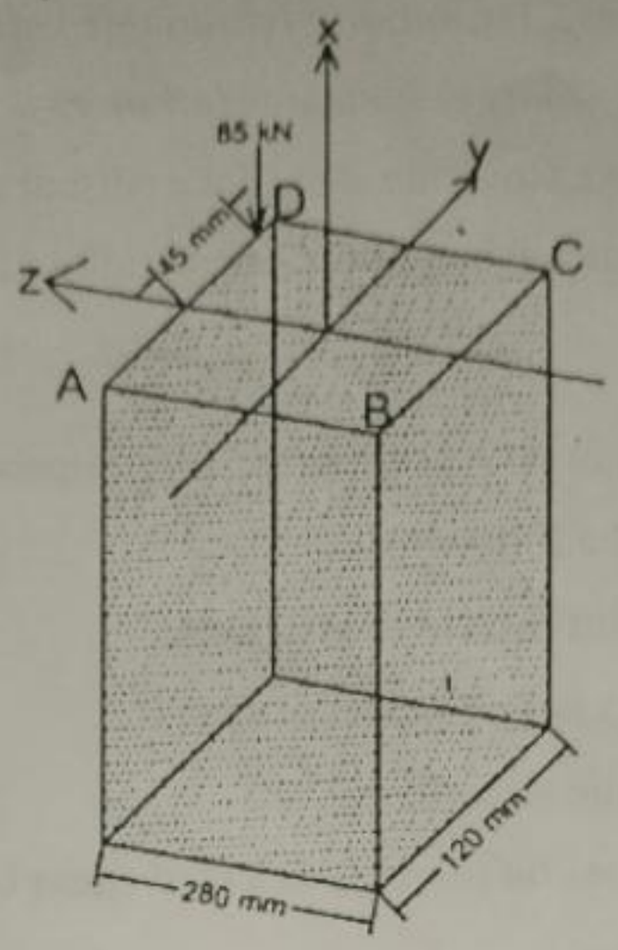

Fig 4.

2. A water tank, 12 ft in diameter, is made from steel plates that are ½ in. thick. [05] Determine the maximum height to which the tank may be filled if the circumferential stress is limited to 4000 psi. The specific weight of water is 62.4 lb/ft^3. [Consider both uniform and non-uniform distribution of pressure] *[CO3, C4]* 64.3

Necessary Equations

$$\sigma_{x'} = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2}\cos 2\theta + \tau_{xy}\sin 2\theta$$

$$\tau_{x'y'} = -\frac{\sigma_x - \sigma_y}{2}\sin 2\theta + \tau_{xy}\cos 2\theta$$

$$\sigma_{y'} = \frac{\sigma_x + \sigma_y}{2} - \frac{\sigma_x - \sigma_y}{2}\cos 2\theta - \tau_{xy}\sin 2\theta$$

$$\tan 2\theta_p = \frac{\tau_{xy}}{(\sigma_x - \sigma_y)/2}$$

$$\sigma_{max,\ min} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + (\tau_{xy})^2}$$

$$\tan 2\theta_s = -\frac{(\sigma_x - \sigma_y)/2}{\tau_{xy}}$$

$$\tau_{max} = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + (\tau_{xy})^2}$$