School of Engineering and Applied Science (SEAS), Ahmedabad University

Name: _____ Roll no.: _____

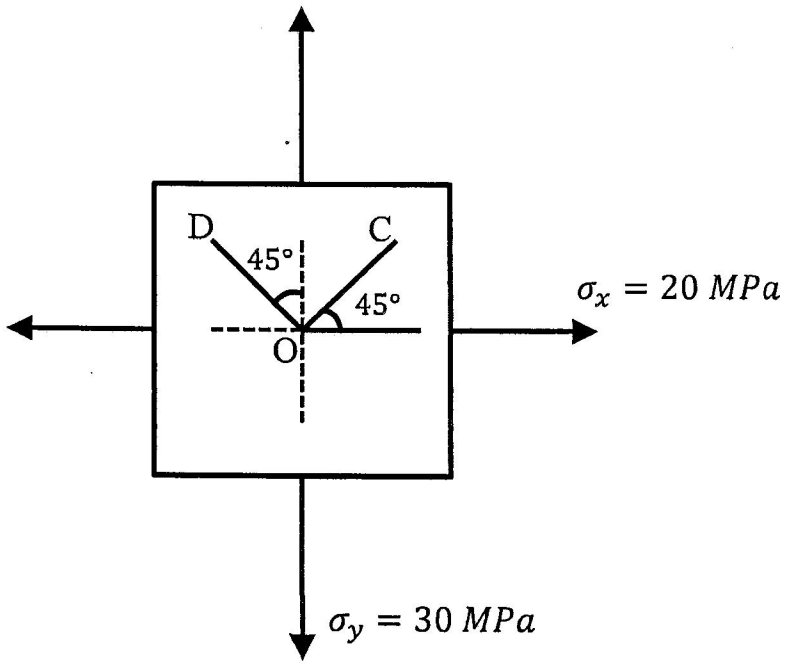
B. Tech. (Mechanical Engineering): Semester V
MEC302 Design, Materials and Manufacturing; Mid-sem Exam (Monsoon 2023); Marks: 25; Wt.: 25%
September 20, 2023; Wednesday, 08.00 AM – 10.00 AM (120 minutes)

Instructions:

1 There are six main questions. Answer any five.
2 The correct approach also carry marks.
3 Numbers to right indicate marks for each question.
4 Use of only a non-programmable scientific calculator is allowed for calculation.

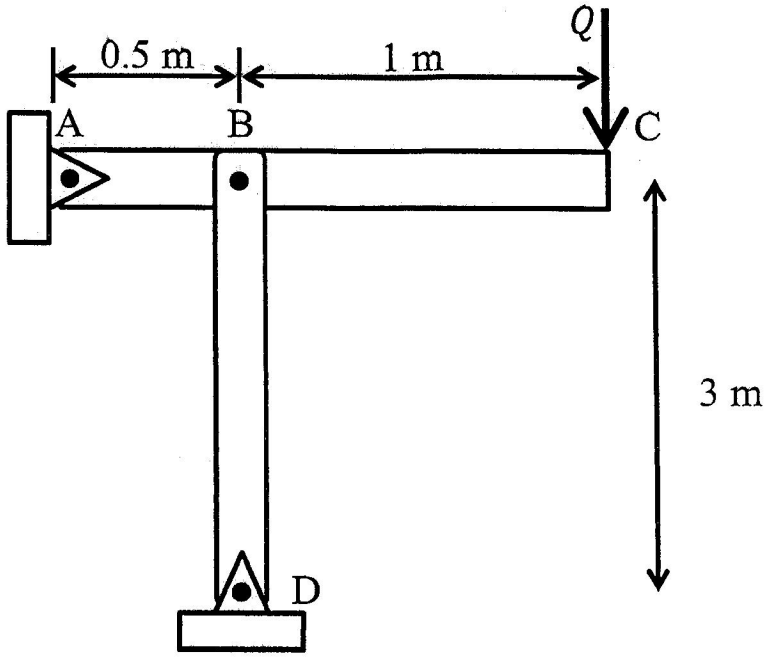
Q-1. How much change in the magnitude of volume (in cubic mm) would a 100 mm side cube of steel will have when it is kept at a depth of 2 km in sea water? Assume specific gravity of sea water 1.02. Take modulus of elasticity of steel as 208 GPa, Poisson's ratio equal to 0.29, $g = 10\,m/s^2$ and reference density of water as 1000 kg/m^3. If you think you would require a relation between elastic modulus, you may use $E = 3K(1-2\vartheta)$ and/or $E = 2G(1+\vartheta)$, where symbols have their standard meaning. **[5]**

Q-2. A 1 $m \times 1\ m$ mild steel shell of 1 mm thickness is stretched on its own plane by stresses $\sigma_x = 20\ MPa$ and $\sigma_y = 30\ MPa$ as shown in the figure. The point O is the centre of the plane. OC and OD are two mutually perpendicular lines inclined at 45° to x- and y- directions, respectively, before applying stresses. Determine the change in angle (in degree) between OC and OD after the application of stresses. Take the modulus of rigidity of the plane material as 80 MPa. **[5]**



Q-3. The cap on a cylindrical tank is bolted to the tank along the flanges. The tank has an inner diameter of 1.5 m and a wall thickness of 18 mm. If the pressure in the tank is 1.2 MPa, what will be the force in each of the 16 bolts used to attach the cap to the tank? Also, specify the state of stress in the wall of the tank. **[5]**

Q-4. A pinned end column BD supports a horizontal rigid bar ABC, as shown in the figure. The column is a steel bar ($E = 200\ GPa$) of square cross-section ($50\ mm$ side). Find out the allowable load Q if the factor of safety with respect to buckling of the column is 3. **[5]**



Q-5. A round mechanical member is subjected to a direct tensile load of 20 kN and a shear load of 12 kN. The yield strength of the material in tension is 245.2 N/mm^2, and Poisson's ratio 0.3. As a design engineer, what diameter (in mm) for the member would you advise at a factor of safety of 2? You can use failure criteria according to the maximum principal strain theory (ST. Venant's) or the maximum strain energy theory (Beltrami Haigh's). Justify your choice of the failure theory being used. **[5]**

Q-6. The deflection curve for a supported beam of length L and elastic modulus E, and second moment of area I, is given by

$$y = \frac{w_0 L^4}{\pi^4 EI} \sin \frac{\pi x}{L}$$

Find the expression for the load acting on the beam. **[5]**

*******All the best*******