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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER II
SESSION 2014/2015**

COURSE NAME	: SOLID MECHANICS 1
COURSE CODE	: BDA 10903
PROGRAMME	: BDD
EXAMINATION DATE	: JUNE 2015 / JULY 2015
DURATION	: 3 HOURS
INSTRUCTION	: ANSWER FIVE (5) QUESTIONS ONLY.

THIS QUESTION PAPER CONSISTS OF SEVEN (7) PAGES

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Q1. **Figure Q1** demonstrates a structure AB connected with cable BC. The 4 mm diameter cable of BC is made of steel with Young's Modulus of 200 GPa. (Knowing that the cable maximum stress and elongation must not exceed 190 MPa and 6 mm respectively).

- a) Determine the maximum load P that can be applied. (12 marks)
- b) If the load P is applied at the centre of structure AB, and the other parameters are remained constant, determine what would be the value of the new P .

(8 marks)

Q2. A 15 m over-hanging beam support loads and a couple moment as shown in **Figure Q2**.

- a) Determine the reaction forces at A and D. (4 marks)
- b) Write all equations for each section of the beam. (6 marks)
- c) Draw the shear and bending moment diagrams. (6 marks)
- d) Determine the points of contra-flexure. (4 marks)

Q3. The low strength concrete floor slab is integrated with a wide-flange A-36 steel beam using shear studs to form a composite beam as shown in **Figure Q3**. If the allowable bending stresses for concrete and steel are 10 MPa and 165 MPa respectively, determine

- a) the neutral axis of the structure (6 marks)
- b) the moment of inertia, and (5 marks)
- c) the maximum allowable internal moment M that can be applied to the beam (9 marks)

Q4. a) State FOUR (4) assumptions to determine the relationship of the shearing stress in circular shaft subjected to torsions.

(4 marks)

b) Two solid steel shafts are connected by gears as shown in **Figure Q4**. Knowing that the shear modulus, G of the shaft is 77 GPa and the radius of gears B and C are 20 mm and 60 mm respectively. When a torque $T_A = 75 \text{ Nm}$ is applied at A, determine the angle of rotation of end A.

(16 marks)

Q5. An internal pressure, P of 12 MPa is applied to a cylinder tank with hemispherical end shape as shown in **Figure Q5**. The length and the internal diameter, d of the cylinder are 150 mm and 100 mm respectively. Assuming that there shall be no distortion at the junction and the tensile hoop stress will not exceed 120 MPa. Use $E = 170 \text{ GPa}$ and $\nu = 0.28$. Calculate;

a) the minimum allowable thickness of the tank (7 marks)

b) the hoop strain in the cylinder (3 marks)

c) the change in volume in the tank (10 marks)

Q6. The axle of an automobile is acted upon by the forces and couple as shown in **Figure Q6**. Knowing that the solid axle diameter is 32 mm. Determine;

a) the principal planes and principal stresses at point H located on top of the axle (15 marks)

b) the maximum shearing stress at the point. (5 marks)

- END OF QUESTIONS -

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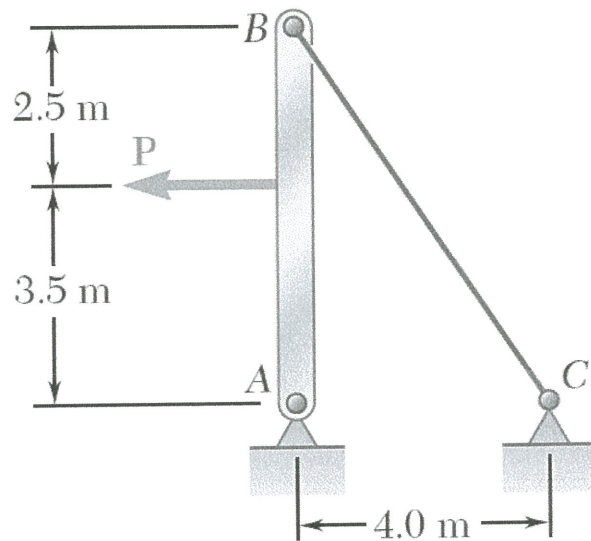


Figure Q1

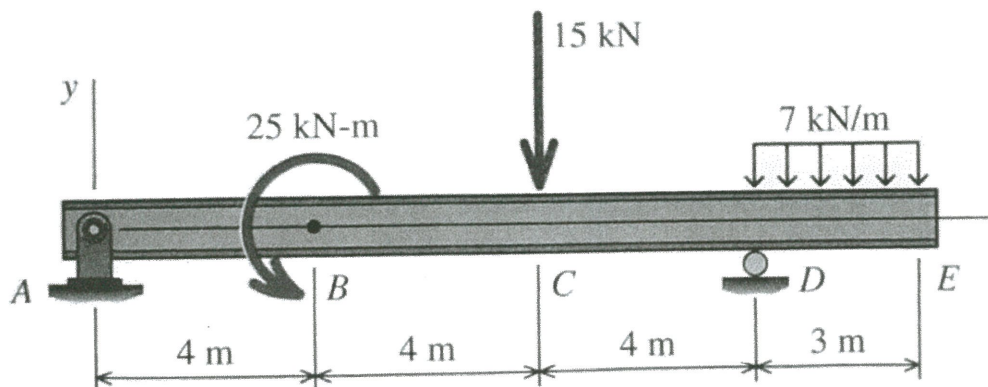


Figure Q2

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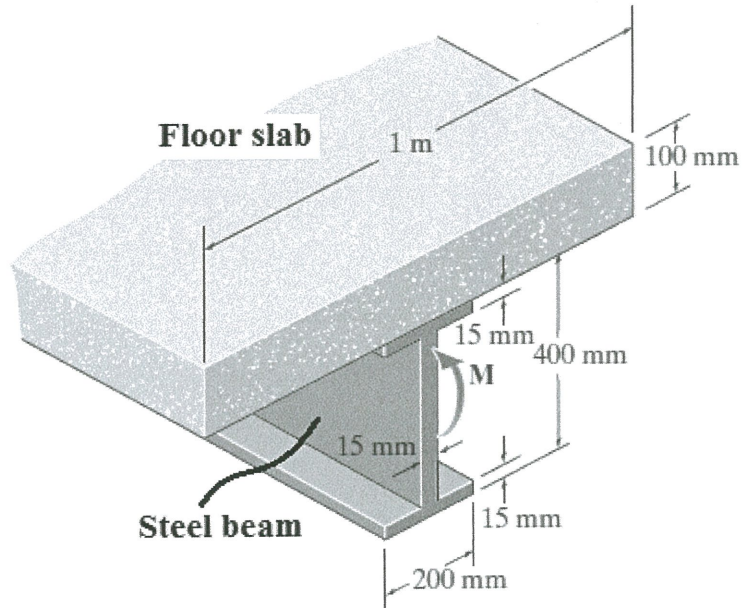


Figure Q3

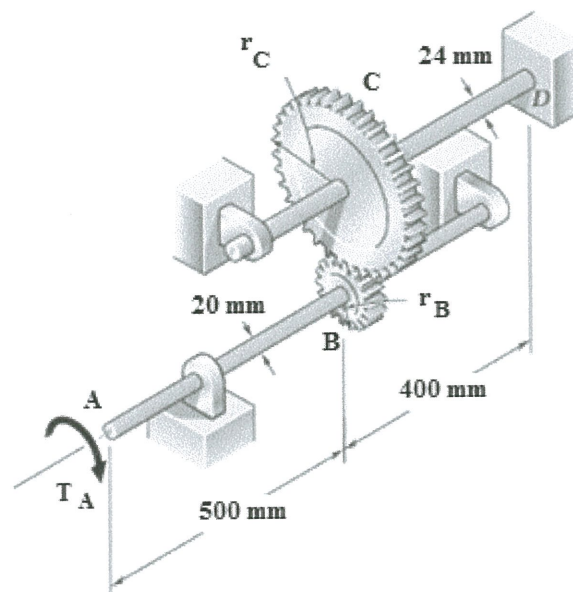


Figure Q4

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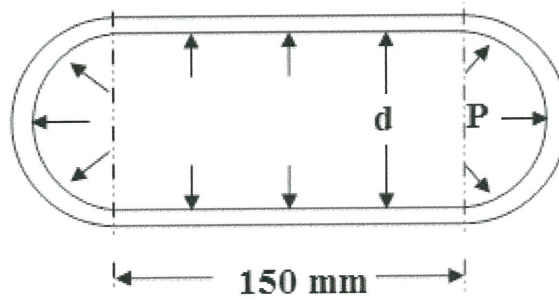


Figure Q5

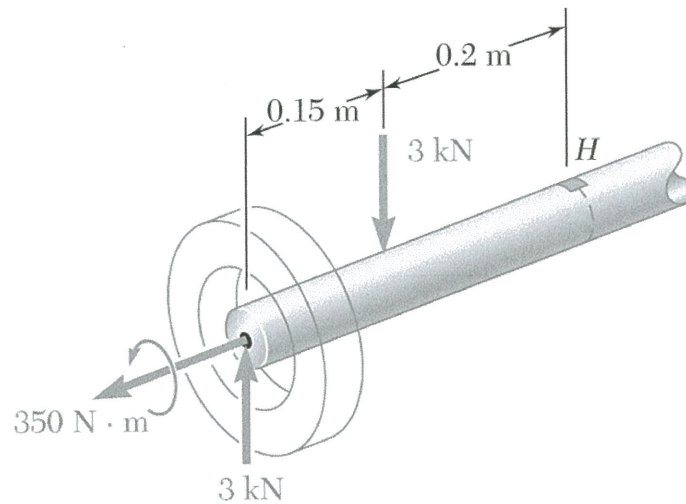


Figure Q6

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Stress Transformation Equations

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

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

Principal Stress

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

$$\sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

Maximum in-plane shear stress

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

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

$$\sigma_{\text{avg}} = \frac{\sigma_x + \sigma_y}{2}$$

Absolute maximum shear stress

$$\tau_{\max}^{\text{abs}} = \frac{\sigma_{\max} - \sigma_{\min}}{2}$$

$$\sigma_{\text{avg}} = \frac{\sigma_{\max} + \sigma_{\min}}{2}$$