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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2010/2011

COURSE	:	SOLID MECHANICS 1
COURSE CODE	:	BDA 1042/ BDA10402
PROGRAMME	:	BACHELOR OF MECHANICAL ENGINEERING WITH HONOURS
EXAMINATION DATE	:	APRIL/ MAY 2011
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** OUT OF SIX (6) QUESTIONS

THIS PAPER CONSIST OF SEVEN (7) PAGES

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Q1 **FIGURE Q1** shows a rigid beam AB suspended horizontally from rods C and D. Rod C made of steel with diameter of 20 mm and rod D made of copper with diameter of 25 mm. If the beam is to remain horizontal after the deformation of the rods, calculate:-

(a) The distance *x*, measured from point A where the load P could be applied (10 marks)

(b) The stresses that occur in the rods C and D, if P = 20 kN? (10 marks)

Given E_{st} = 200 GPa, E_{co} = 120 GPa

Q2 A beam ACDB is loaded with two concentrated load of 400 N as shown in **FIGURE Q2**.

(a) Calculate the reaction forces at A and F. (6 marks)

(b) Draw the free body diagram (FBD) of the beam. (2 marks)

(c) Draw the Shearing Force Diagram (SFD) and the Bending Moment Diagram (BMD) of the beam. (8 marks)

(d) Determine the maximum absolute value of the shear and the bending moment. (4 marks)

Q3 The horizontal bar AB of a swing set shown in **FIGURE Q3** is made of steel pipe of 50 mm inner diameter with 5 mm thickness. Two steel wires with diameter of 3 mm are also being used to hang the swing. If the allowable stress of steel is 250 MPa, compute:-

(a) The reaction force at both ends A and B. (4 marks)

(b) The maximum bending moment and their location (6 marks)

(c) What is the maximum mass of a person who may safely use the swing with a safety factor of 4? (10 marks)

Q4 A combination of solid shaft *BC* and hollow shaft *AC* is used to transmit 12 kW power from the motor *M* to a belt transmission system located at *C* where *AC* = *BC* as shown in **FIGURE Q4**. The shaft is 1.5 m long with outer diameter of 40 mm and the inner diameter for the hollow shaft is 20 mm. The shaft is made of steel with the shear modulus of elasticity is 80 GPa. The maximum speed of rotation of the shaft is 180 rpm. The cross sectional dimension of the belt is 5 mm and 20 mm in thickness and width respectively. The initial stress in the belt before the motor is in operation is 50 MPa, the belt constant of elasticity is 10 kN/m and the pulley *C* diameter is 100 mm.

a) Determine the maximum torque at pulley *C*.

(3 marks)

b) If the torque at *B* is 300 Nm in direction opposite to the torque at *C*, find the corresponding maximum angle of twist of the shaft.

(9 marks)

c) Assuming no slip or creep occurs between the pulley and the belt and the change in belt cross sectional area is negligible, determine the stresses in the top and bottom belts when the motor is operating at its maximum speed.

(8 marks)

Q5 The cap on the cylindrical tank is bolted to the tank along the flanges as in **FIGURE Q5**. The tank has an inner diameter of 1.5 m and a wall thickness of 18 mm. Each bolt has a diameter of 20 mm and the allowable stress for the bolts is 180 MPa. If the largest normal stress is not to exceed 150 MPa, determine:-

(a) The maximum pressure the tank can sustain (10 marks)

(b) The number of bolts required to attach the cap to the tank (10 marks)

Q6 A square wooden plank with grain direction creating 15° to the vertical is subjected to the stresses as shown in **FIGURE Q6**. By the use of plane stress transformation equations, determine:-

(a) Normal stress perpendicular to the grain (10 marks)

(b) The shearing stress in the direction of the grain (10 marks)

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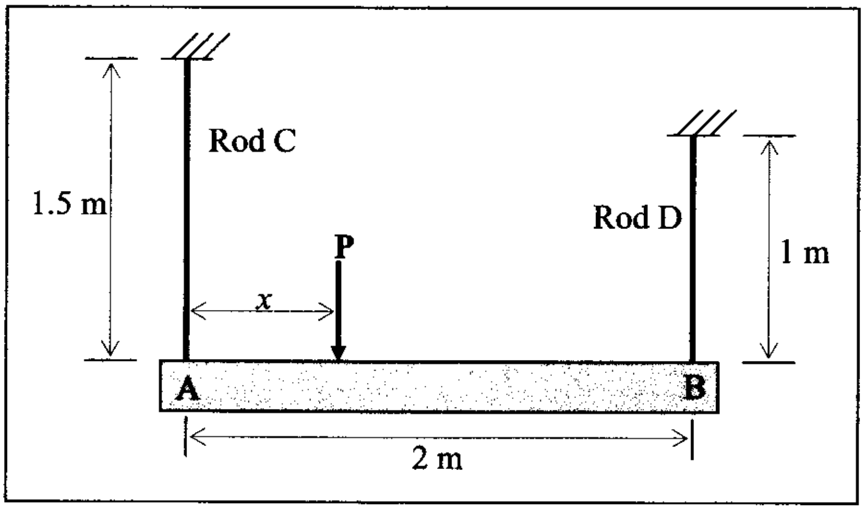

FIGURE Q1

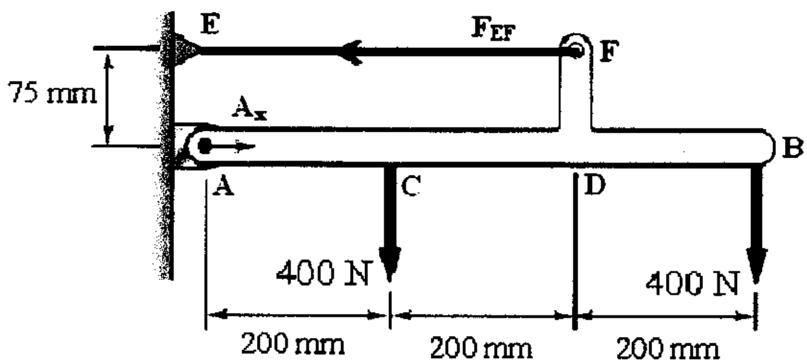

FIGURE Q2

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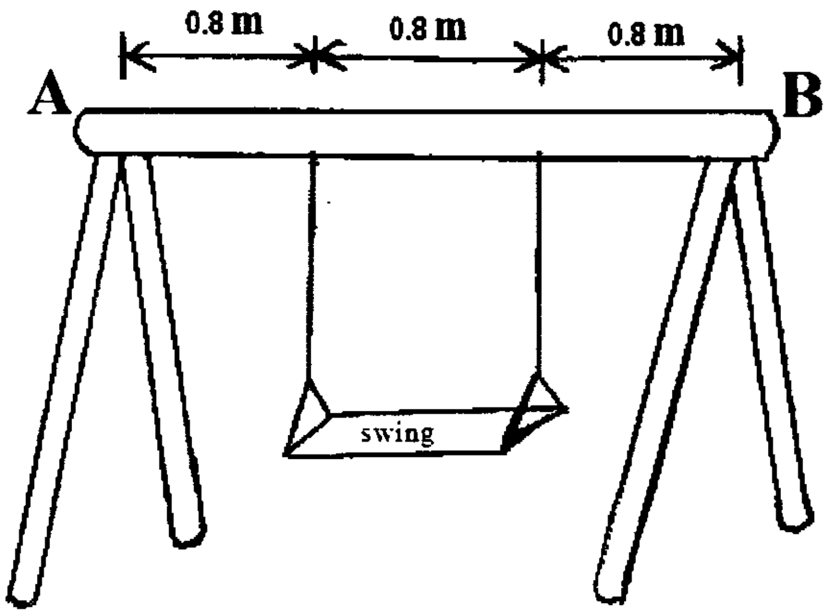

FIGURE Q3

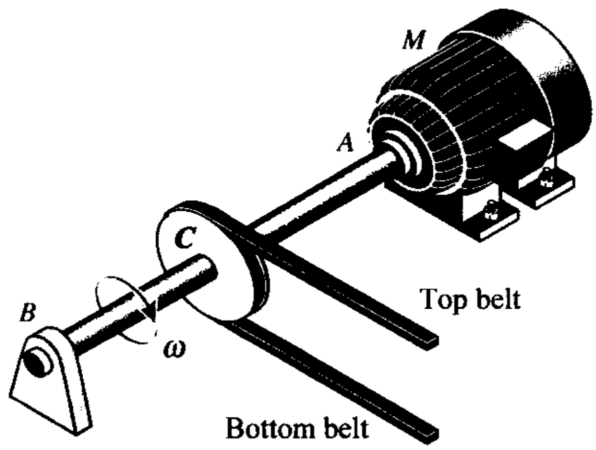

FIGURE Q4

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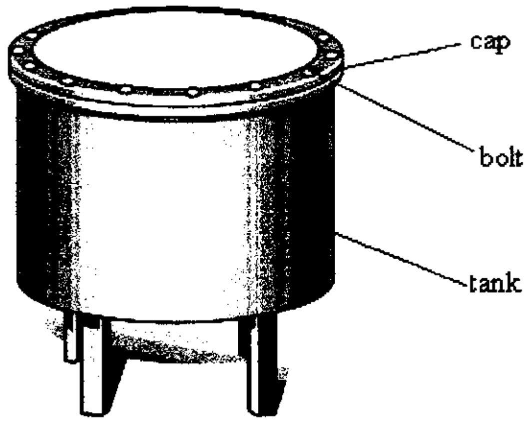

FIGURE Q5

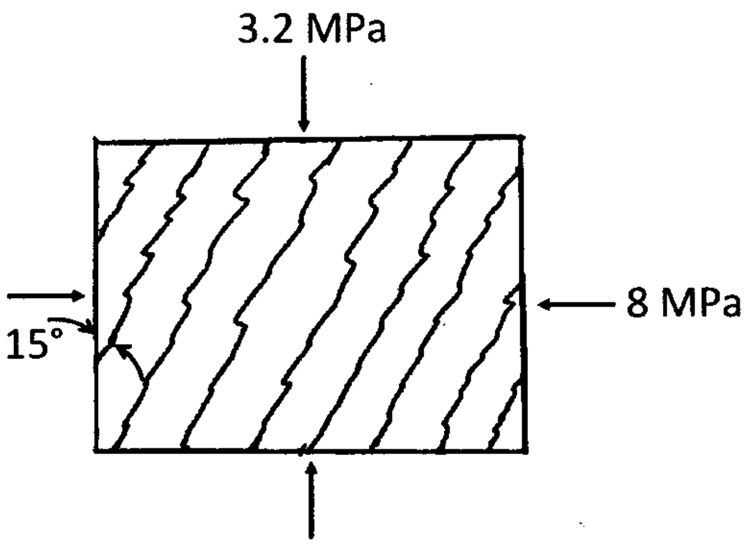

FIGURE Q6

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$$\sigma = \frac{P}{A};\ \tau = \frac{P}{A};\ \sigma_b = \frac{P}{td}$$

$$\sigma_{all} = \frac{\sigma_U}{F.S};\qquad \varepsilon = \frac{\delta}{L};\qquad \sigma = E\varepsilon$$

$$\delta = \frac{PL}{AE};\qquad \delta = \sum_i \frac{P_i L_i}{A_i E_i}$$

$$\delta_T = \alpha(\Delta T)L;\qquad \varepsilon_T = \alpha \Delta T$$

$$v = -\frac{\varepsilon_y}{\varepsilon_x} = -\frac{\varepsilon_z}{\varepsilon_x};\qquad e = \varepsilon_x + \varepsilon_y + \varepsilon_z$$

$$\varepsilon_x = \frac{\sigma_x}{E} - \frac{v\sigma_y}{E} - \frac{v\sigma_z}{E}$$

$$\varepsilon_y = -\frac{v\sigma_x}{E} + \frac{\sigma_y}{E} - \frac{v\sigma_z}{E}$$

$$\varepsilon_y = -\frac{v\sigma_x}{E} - \frac{v\sigma_y}{E} + \frac{\sigma_z}{E}$$

$$\tau_{xy} = G\gamma_{xy}$$

$$\gamma = \frac{\rho\phi}{L};\qquad \gamma = \frac{\rho}{c}\gamma_{max}$$

$$\tau_{max} = \frac{Tr}{J}$$

$$\phi = \frac{TL}{JG};\qquad \phi = \sum_i \frac{T_i L_i}{J_i G_i}$$

$$\sigma = \frac{My}{I};$$

$$\frac{dV}{dx} = -w;\qquad \frac{dM}{dx} = V$$

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

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

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

$$\sigma_{ave} = \frac{\sigma_x + \sigma_y}{2}$$

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

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

$$\tan 2\theta_S = -\frac{\sigma_x - \sigma_y}{2\tau_{xy}}$$

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

$$\sigma_1 = \frac{pr}{t};\qquad \sigma_2 = \frac{pr}{2t}$$

retangle

$$I = \frac{1}{12}bh^3;\qquad J_O = \frac{1}{12}bh(b^2 + h^2)$$

circle

$$I = \frac{1}{4}\pi r^4;\qquad J_O = \frac{1}{2}\pi r^4$$

hollow

$$J_O = \frac{1}{2}\pi(r_2{}^4 - r_1{}^4)$$