The Open University of Sri Lanka
Faculty of Engineering Technology

Study Programme	:	Diploma in Technology/Bachelor of Technology (Engineering)
Name of the Examination	:	Final Examination
Course Code and Title	:	**MEX5232 Strength of Materials II**
Academic Year	:	2015/16
Date	:	16th November 2016
Time	:	0930hrs – 1230hrs
Duration	:	3 hours

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of 8 questions.
3. Answer any 5 questions. All questions carry equal marks.

Q1 *Figure Q1(a)* shows a beam AB with point loads W_1 and W_2.

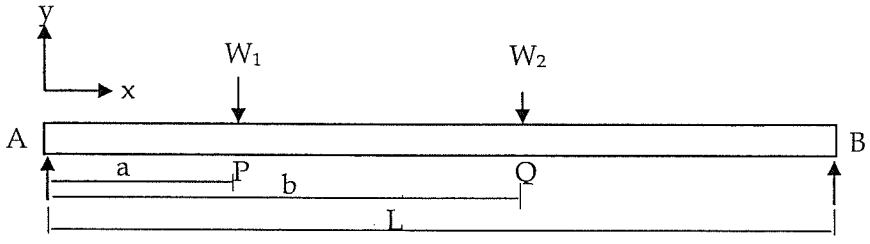


Figure Q1(a)

a) Using Mecaulay's Method of Integration, determine
   I. the support reactions.
   II. deflections at points P and Q.

[10 Marks]

b) *Figure Q1(b)* shows a horizontal steel grinder having uniform cross section of 14 m long, is simply supported at its ends. It carries two concentrated loads at points C and D, 12 kN and 8 kN respectively.
Calculate the deflection of the beam under the loads C and D, if modulus of elasticity of the beam(E) =200 GPa and second moment of area(I) = 160×10^6 mm^4

[10 Marks]

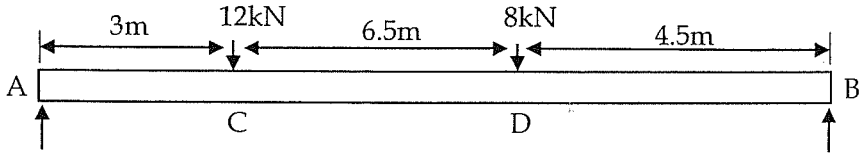


Figure Q1(b)

Q2 a) State the First and Second theorems of Moment-Area method used to determine the deflection of beams.

[4 Marks]

b) AB is a symmetrically loaded beam which is made of mild steel, carries two point loads as shown in *Figure Q2* at C and D.

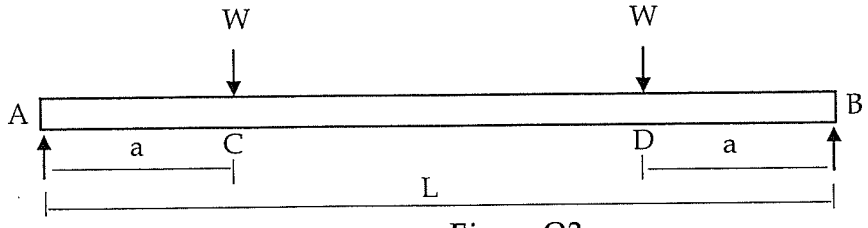


Figure Q2

i) Sketch bending moment diagrams of each part.

[6 Marks]

ii) Compute mid span deflection of the beam in terms of ***EI, W,*** **a** and **L,** where,

a - Length of AC and BD.
L - Length of the beam AB
E - Modulus of Elasticity
I – Second Moment of Area

[6 Marks]

iii) Discuss the situation of the beam when **a = L/2.**

[4 Marks]

Q3 a) Stating all the assumptions, derive the torsion formula for solid circular shafts.

$$\frac{T}{J} = \frac{G\theta}{L} = \frac{\tau}{r}$$

[10 Marks]

b) A solid shaft having a modulus of rigidity (G) = 83GPa is subjected to a torque of 1500Nm. The maximum allowable shear stress of the shaft 40MPa and allowable twist is 2^0 per meter length.
To satisfy the requirements, determine a suitable diameter for the shaft.

[10.0 Marks]

Q4 a) Show that bending moment M_{PP} carried by a rectangular beam section having width *B* and depth *D* is given by,

$$M_{pp} = \frac{B(3D^2 - d^2)}{12}\sigma_y$$

if the plastic yielding has taken place to depth of *d/2* measured from neutral axis.

[6 Marks]

b) A steel beam having a rectangular section, 60mm width and 40mm depth is simply supported over a length of 1.5m, 40mm side being vertical.

(i) Determine the value of uniformly distributed load that initiate yielding at outer fibers of the beam.

[8 Marks]

(ii) If the load is increased by 10%, find the depth of plastic deformation, at the mid span of the beam.
Yield stress of steel is 220MN/m²

[6 Marks]

Q5 a) Assuming that the longitudinal stress is constant across the cylinder walls, derive Lame equations for stresses set up in thick cylinders.

[6 Marks]

b) By taking the usual notations, find out the radial stress and the hoop stress of a thick cylinder when it is subjected to internal pressure only condition.
Draw the stress distribution for each case.

[6 Marks]

c) A thick metallic cylindrical shell of 150mm internal diameter is required to withstand an internal pressure of 8 N/mm². Find the necessary thickness of the shell using above derivations, if permissible tensile stress in the section is 20 N/mm².

[8 Marks]

Q6 a) Assume that the zero longitudinal stress across the cylinder walls, derive an equation for total shrinkage of a compound cylinder which is made from two different materials.

[8 Marks]

b) Two steel rings of radial thickness 30 mm, common radius 70 mm and length 40 mm are shrunk together to form a compound ring. It is found that the axial force required to separate the rings, i.e. to push the inside ring out, is 150 kN.

Determine the shrinkage pressure at the mating surfaces and the shrinkage allowance, if Modulus of Elasticity (E) = 208 GN/m² and coefficient of friction between the junction surfaces of the two rings is 0.15.

[12 Marks]

Q7 a) Derive equations for radial and hoop stresses for **wire wound thick cylinder**.

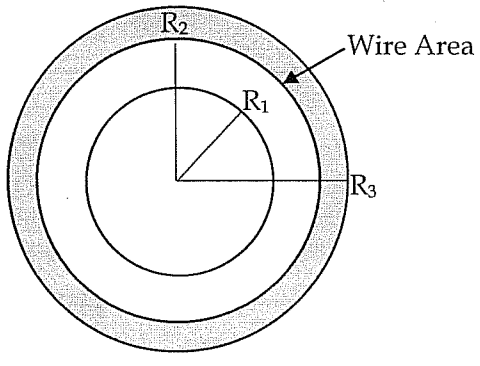


Figure Q7

Use following equations

$$\sigma_r = -\left(\frac{P_w R_2^2}{R_2^2 - R_1^2}\right)\left(1 - \frac{R_1^2}{r^2}\right)$$

$$\sigma_H = -\left(\frac{P_w R_2^2}{R_2^2 - R_1^2}\right)\left(1 + \frac{R_1^2}{r^2}\right)$$

$$\sigma_r + r\frac{d\sigma_r}{dx} = \sigma_H$$

where,

σ_r= Radial stress of a single thick cylinder
σ_H= Hoop stress of a single thick cylinder
P_w= External pressure on the tube caused due to wire tension
R_1= Internal radius of the cylinder
R_2 = External radius of the cylinder
R_3 = Radius of the wire wound thick cylinder as shown in ***Figure Q7***

[8 Marks]

b) A thick cylinder of 100 mm external diameter and 50 mm internal diameter is wound with steel wire of 1 mm diameter, initially stressed to 20 MN/m^2 until the outside diameter is 120 mm.

Determine the maximum hoop stress set up in the cylinder if an internal pressure of 30 MN/m^2 is applied.

[12 Marks]

Q8 a) The stresses in a thin rotating disk(under plane stress conditions) are given by,

$$\sigma_r = A - \frac{B}{r^2} - (3+v)\frac{\rho r^2 \omega^2}{8}$$

$$\sigma_H = A + \frac{B}{r^2} - (1+3v)\frac{\rho r^2 \omega^2}{8}$$

I. Derive the equations for maximum and minimum, hoop and radial stresses set up in a solid disc with a central hole in rotation by using above equations.
II. Deduce values of stresses at any radius when the disc has no central hole.

[10 Marks]

b) A steel ring of outer diameter 300 mm and internal diameter 200 mm is shrunk onto a solid steel shaft. The interference is arranged such that the radial pressure between the mating surfaces will not fall below 30 MN/m^2 whilst the assembly rotates in service. If the maximum circumferential stress on the inside surface of the ring is limited to 240 MN/m^2, determine the maximum speed at which the assembly can be rotated. It may be assumed that no relative slip occurs between the shaft and the ring.

For steel, Density (p) = 7470 kg/m^3, Poisson's ratio(v= 0.3), Modulus of Elasticity (E) = 208 GN/m^2.

[10 Marks]

-End-