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The Open University of Sri Lanka
Faculty of Engineering Technology

Study Programme	:	Bachelor of Technology Honors in Engineering
Name of the Examination	:	Final Examination
Course Code and Title	:	**MEX5232 Strength of Materials II**
Academic Year	:	2016/17
Date	:	08th November 2017
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 a) Write down the differential equation for elastic for bending of beams and define its terms.

[3 Marks]

b) Discuss the difference between **Double Integration Method** and **Macaulay's Method of Intergration.**

[2 Marks]

c) A beam of length of ***12L*** carries a uniformly varying distributed load on half its length as shown in ***Figure Q1.***

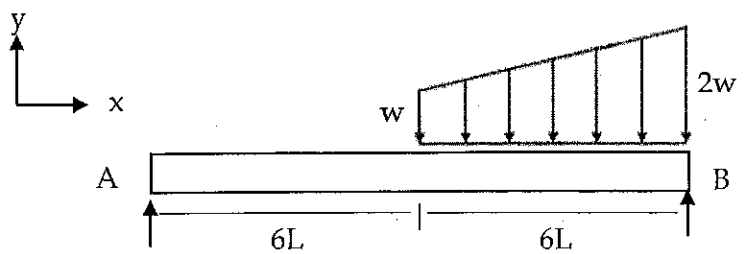


Figure Q1

i) Determine the support reactions at A and B.
ii) Write the equation for bending moment using Macaulay's Method.
iii) Derive the deflection equation for the elastic curve.

[15 Marks]

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 cantilever beam of length L on which is made of mild steel, carries two point loads as shown in *Figure Q2* at A and C.

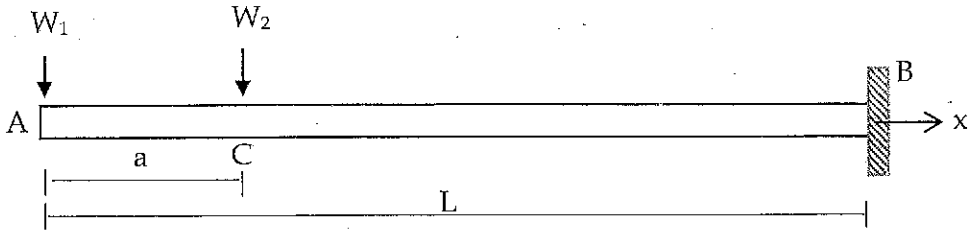


Figure Q2

i) Sketch bending moment diagrams of each part.

[8 Marks]

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

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

[8 Marks]

Q3 a) Write down the equation for shear stress induced in the thin wall tubes when it is subjected to a torque, defining each parameters.

[6 Marks]

b) A thin walled circular tube of 100 mm diameter and 2 m in length is firmly restrained at both ends against rotation. A torque of 10 kNm is applied at the midpoint of the span. Determine,

i) minimum thickness of the tube considering the maximum permissible shear stress as 200 MN/m^2.

[6 Marks]

ii) minimum thickness based on maximum angle of twist of 3 degrees.

[8 Marks]

Take Modulus of Rigidity of the tube material is 300 GN/m^2.

Note:
You may use the following equation with usual notations.

$$\theta = \frac{LTZ}{4A^2tG}$$

θ - Angle of twist
L - Length of the tube
T- Total torque
G- Modulus of Rigidity
A - Cross section area
Z - Circumference Length
t - Thickness of the wall

Q4 A steel beam having a rectangular section, 50mm width and 30mm depth is simply supported over a length of 1.5m, 30mm side being vertical.

i. Determine the value of the central concentrated load that initiate yielding at outer fibers of the beam.

[8 Marks]

ii. If the central load is increased by 10%, find the depth of plastic deformation, at the mid span of the beam.
Yield stress of steel is 240MN/m^2

[6 Marks]

iii. What are the maximum deflections under loads given in (i) and (ii)?

[6 Marks]

Note:

Bending moment M_{PP} with yield stress σ_y ,carried by a rectangular beam section having width B and depth D is given by,

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

And maximum deflection δ for **w** load at the center of the beam is given by,

$$\delta = \frac{wL^3}{48EI}$$

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

[4 Marks]

b) By taking the usual notations, derive the equations for radial stress and the hoop stress of a thick cylinder when it is subjected to internal pressure only condition.

[6 Marks]

c) A thick cylinder of 100 mm internal radius and 150 mm external radius is subjected to an internal pressure of 60 MN/m^2 and an external pressure of 30 MN/m^2. Using **Graphical Method,** determine the hoop and radial stresses at the inside and outside of the cylinder together with the longitudinal stress if the cylinder is assumed to have closed ends.

[10 Marks]

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

[8 Marks]

b) A steel sleeve of 150 mm outside diameter is to be shrunk on to a solid steel shaft of 100 mm diameter. If the shrinkage pressure set up is 15 MN/m^2.

i. find the initial difference between the inside diameter of the sleeve and the outside diameter of the shaft.

ii. what percentage error would be involved if the shaft were assumed to be incompressible?

Note: For steel, Modulus of Elasticity (E) = 208 GN/m^2; coefficient of friction (υ) between the junction surfaces of the two rings = 0.3.

[12 Marks]

Q7 a) What are the stresses set up in a rotating solid disc? Briefly describe each of them. [5 Marks]

b) A steel ring 300 mm outer diameter and 200 mm inner diameter has been shrunk onto a solid shaft with interface. When the shaft rotates at 6000 rpm the interface pressure is 20 MN/m^2. Determine,

i. the circumferential stress at the inner radius of the ring.

ii. the speed at which the interface pressure reduces to 10 MN/m^2.

Note: The radial stress and the circumference stress of a rotating disc are given by following formulae with usual notations.

$$\sigma_r = A - \frac{B}{r^2} - K_1 r^2 \omega^2$$

$$\sigma_H = A + \frac{B}{r^2} - K_2 r^2 \omega^2$$

K_1 and K_2 are constants, depend on materials properties and can be assumed as 3000 kg/m^3 and 1700 kg/m^3 respectively.

[15 Marks]

Q8 Write short notes on following topics with appropriate illustrations.

a) Usage of compound cylinders in engineering applications [5 Marks]

b) Unsymmetric bending of beams [5 Marks]

c) Plastic hinge of loaded beams [5 Marks]

d) Maximum shear stress criteria for elastic failure [5 Marks]

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