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The Open University of Sri Lanka
Faculty of Engineering Technology

Study Programme	:	Bachelor of Technology Honours in Engineering
Name of the Examination	:	Final Examination
Course Code and Title	:	**DMX4575 Strength of Materials I** MEX4275
Academic Year	:	2017/18
Date	:	16th February 2019
Time	:	0930hrs – 1230hrs
Duration	:	3 hours

General instructions

1. Read instructions given below carefully before answering the questions.
2. This question paper consists of eight (08) questions. Answer any five (05) questions.
3. All questions carry equal marks.

Question No.01:

a) Explain the assumptions made in Euler's theory.

b) Define the terms column, strut and crippling load.

c) Prove that the crippling load by Euler's formula for a column having one end fixed and other end free is given by

$$P = \frac{\pi^2 EI}{4l^2}$$

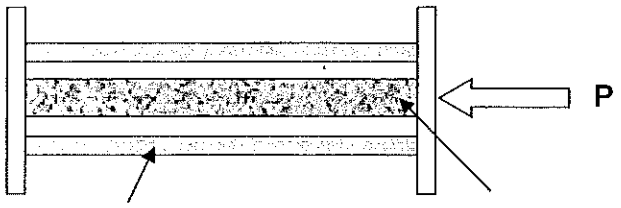
Where l = Actual length of the column

E = Young's modulus

I = Relevant second moment of area of the column cross section

Question No.02:

a) Fig.Q2(a) shows a compound bar of length **L**, made up of a rod (r) placed inside a sleeve (s) which are made of different materials. The ends are connected and restrained so that they elongate together. If a load **P** is acting on the compound bar what would be the loads taken by each component?



Sleeve (s)
Cross sectional area – A_s
Modulus of elasticity - E_s

Rod (r)
Cross sectional area – A_r
Modulus of elasticity – E_r

Fig.Q2(a)

b) A concrete column with 1.35 m height is reinforced with six identical steel bars each with a 28 m diameter (Fig.Q2(b)). Determine the normal stress in the steel bars and in the concrete when a 1560 kN axial centric force P (compressive) is applied to the column. Modulus of Elasticity of steel is 200 GPa and that of concrete 29 GPa.

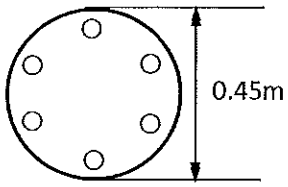


Fig.Q2(b)

Question No.03:

a) Write down the simple torsion formula

b) A uniform hollow circular cylindrical shaft has a cross section with an inner radius 'a' and outer radius 'b' and length 'l'. Show that the torque applied in terms of geometrical parameters and material properties of the cylinder within the linear elastic range is given by

$$T = \frac{\pi}{2}(b^4 - a^4)\frac{G}{l}$$

c) Determine the torque that can be applied to a solid shaft of 20 mm diameter without exceeding an allowable shearing stress of 80 MPa.

d) Assuming that the solid shaft has been replaced by a hollow shaft of the same cross-sectional area and with an inner diameter equal to half of its own outer diameter, what is the new torque that can be applied to the shaft without exceeding the same shearing stress as in part (c).

Question No.04:

a) State bending formula with defining any notations and write down the assumptions used to derive this formula.

b)

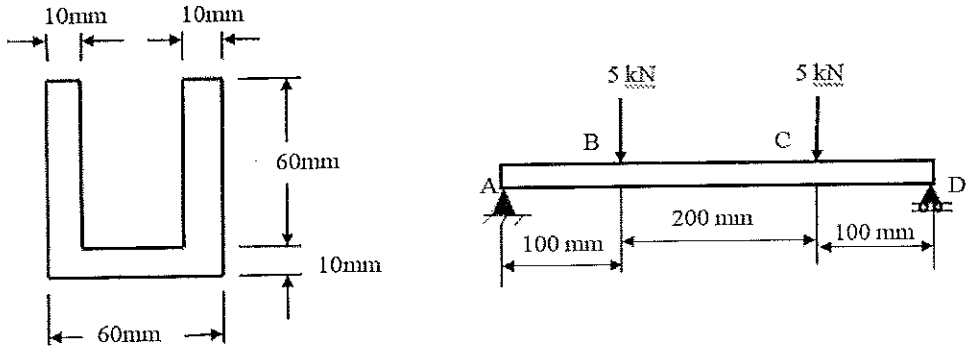


Fig.Q4

Two vertical forces on a simply supported beam on A and D are applied at B and C as shown in Fig.Q4. The cross section of the beam is also shown in the figure with its dimensions. Determine the maximum tensile and compressive stresses at the relevant section between B and C of the beam.

Question No.05:

a) Derive an expression for the stresses (σ_θ, τ_θ) on an oblique plane of a rectangular body, when the body is subjected to tensile stresses in x and y directions as shown in Fig.Q5(a).

b) Determine the magnitudes of σ_θ, τ_θ, when $\theta = 0^0$, 45^0 and 90^0

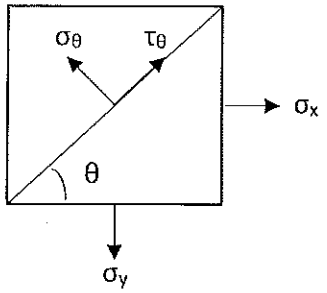


Fig.Q5(a)

c) At a point in a strained material , on plane BC there are normal and shear stresses of 40 N/mm^2 and 35 N/mm^2 respectively. On plane AC, which is perpendicular to BC, there are normal and shear stresses of 60 N/mm^2 and 35 N/mm^2 respectively as shown in Fig.5(b). Determine the following:

(i) Principal stresses and the orientation of the planes on which they act,
(ii) Maximum shear stress and the orientation of the plane where it acts.

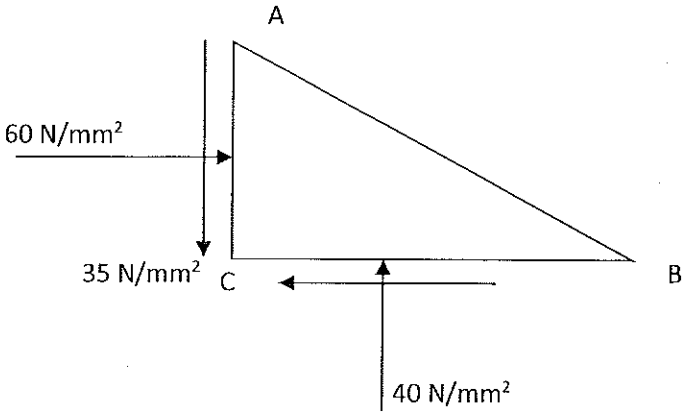


Fig.5(b)

Question No.06:

A beam AB 8 m long carries a uniformly distributed load 10 kN/m over its span together with concentrated load of 30 kN at the left end **A** and 60 kN at the end **B**. The beam is supported on two props C and D at the same level with AC being 2 m and DB 1 m. C and D are 5 m apart as shown in Fig.Q1.

(i) Determine the reaction of each support and draw the Shear Force and Bending Moment diagrams over the beam.
(ii) Find the value and the location of the maximum Bending Moment.
(iii) Locate the point of contra flexure, if any

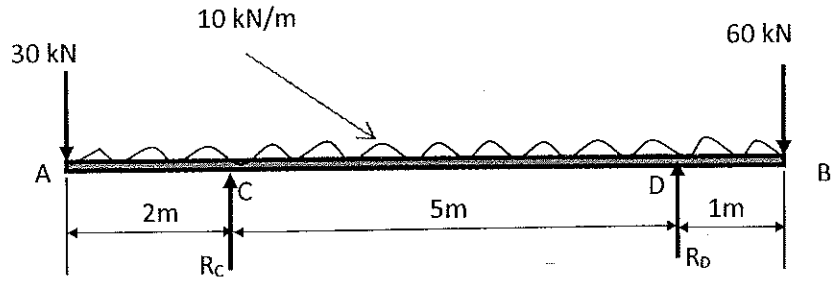


Fig.Q6

Question No.07:

a) A simply supported beam of length L carries a uniformly distributed load w along the length of the beam as shown in Fig.Q7. Show that the maximum bending moment of the beam, $M_{max} = \frac{wL^2}{8}$

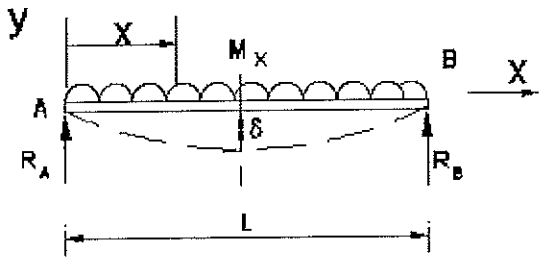


Fig.Q7

b) A steel girder of 6 m length acting as a beam carries a uniformly distributed load '*w*' N/m over its span. If the girder section is uniform and symmetrical with the relevant neutral axis of a depth of 270 mm. The relevant second moment of area of the section, $I = 30 \times 10^{-6}$ m^4. Calculate:

(i) the magnitude of '*w*' so that the maximum stress developed in the beam section does not exceed 72 MN/m^2.

(ii) the slope and deflection (under the given loading conditions) of the beam at a distance of 1.8 m from one end.
Modulus of the rigidity E = 200 GN/m^2

Question No.08:

Briefly explain the following.

a) Hardness

b) Elastic limit of a material

c) Ductility

d) Stiffness

END