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	:	**MEX4275 Strength of Materials I**
Academic Year	:	2014/15
Date	:	19th September 2015
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.

Question No.01:

a) Define the terms stress and strain.

b) A simply supported beam ABCD, 6 m long, is overhanging by 1.5 m and carries appoint load and uniformly distributed load as shown in Fig.Q1.

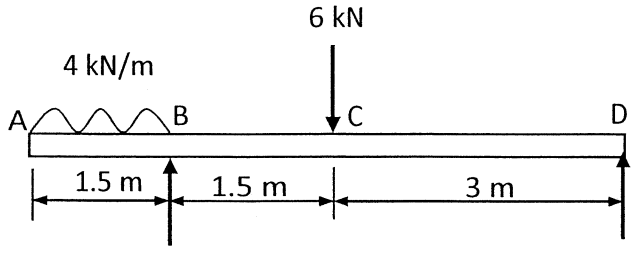


Fig.Q1

Draw the shear force and bending moment diagrams for the beam and locate the point of contra flexure.

Question No.02:

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.Q2.

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

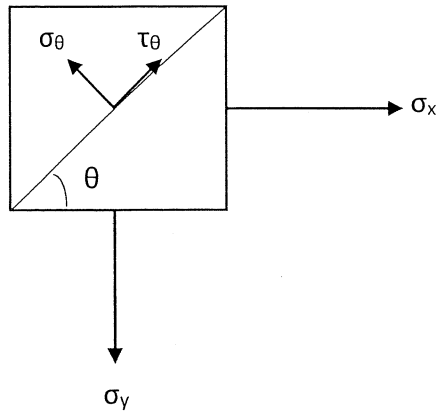


Fig.Q2

c) A structural member is loaded in such a manner that at a particular point in the member, the stresses in a in two dimensional stress system are found to be;

$\sigma_x = +400 \ \ N/mm^2$, $\sigma_y = +300 \ \ N/mm^2$ and $\tau_{xy} = +200 \ \ N/mm^2$.

i) Draw the Mohr's circle for the point representing all the given stresses.

ii) Determine the magnitude and the directions of principal stresses.

iii) Find the magnitude of the maximum shear stress.

Question No.03:

Briefly explain the following.

a) Hardness

b) Elastic limit of a material

c) Ductility

d) Stiffness

Question No.04:

a) State Castigliano's first and second theorems for strain energy.

b)

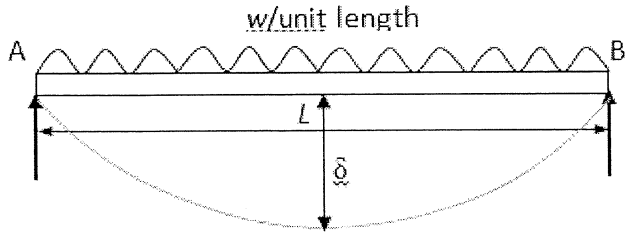


Fig.Q4

A simply supported beam carries a uniformly distributed load of intensity ***w*** over its length ***L*** as shown in Fig.Q4. If the flexural rigidity ***EI*** of the beam is constant, show that the

deflection (δ) at its mid span $= \frac{5wl^4}{384EI}$

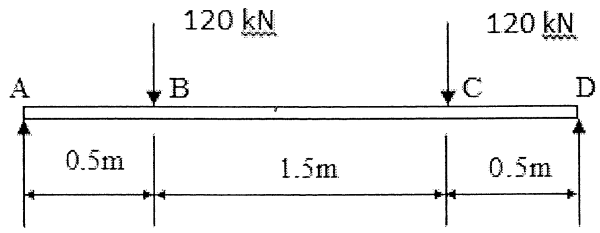
Question No.05:

a) Write down the simple torsion formula and explain all the notations with their units.

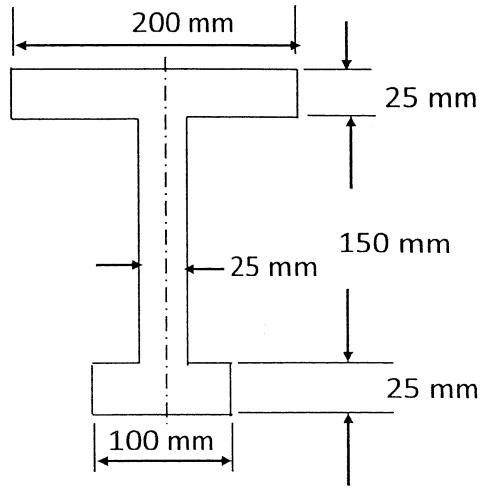
b) What are the assumptions made in the analysis of circular shafts in deriving the torsion formula?

c) A solid shaft having a diameter of 30 mm, transmits 5 kW at 300 rev/min. It is necessary to be replace the solid shaft with a hollow shaft which has the outer diameter twice bigger than the inner diameter. Assuming that both shafts have the same shear stress at the outside radius, determine the outer and inner diameters of the hollow shaft.

Question No.06:



(*a*)



(b)

Fig.Q6

Fig.Q6(*a*) shows a simply supported beam carrying two vertical forces while Fig.Q6(*b*) shows the cross section of the beam.

Determine,

i) the position of the neutral axis from the base of the cross section given in Fig.Q6(*b*).

ii) the second moment of area about the neutral axis.

iii) the maximum tensile and compressive stresses within the portion BC of the beam.

Question No.07:

a) Show that the Euler formula for buckling of struts with built in ends is

$$P_e = \frac{4\pi^2 EI}{L^2}$$

Where P_e - *Critical load*, L – *Length of the strut*, E – *Modulus of elasticity*, I – *Second moment area of the section of the column*

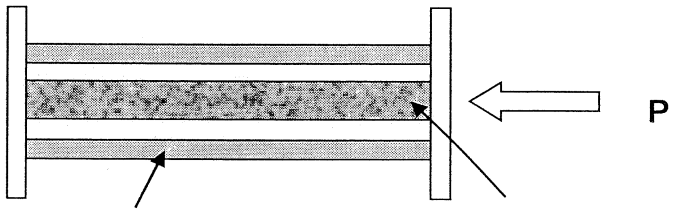
b) A bar of length 4 m when used as a simply supported beam and subjected to a uniformly distributed load of 30 kN/m over the whole span, deflects 15 mm at the center. Determine the crippling load when it is used as a column with following end conditions.

i) Both ends pin jointed
ii) One end fixed and other end hinged
iii) Both ends fixed

Note: The deflection (δ) of the mid span of a simply supported beam which carries a uniformly distributed load of intensity '***w***' over its length '***l***' and the flexural rigidity '***EI***' of the beam can be written as $\frac{5wl^4}{384EI}$

Question No.08:

a) Fig.Q8 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.Q8

b) A concrete column of cross – sectional area 500mm x 500mm is reinforced by four longitudinal 50 mm diameter round steel bars placed at each corner. If the column carries a compressive load of 400 kN and the modulus of elasticity of steel is 15 times that of concrete, determine:

i) the individual loads carried by steel and concrete.
ii) the compressive stress produced in the concrete and steel bars.

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