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	:	**MEX4335 Applied Mechanics & Strength of Materials**
Academic Year	:	2016/17
Date	:	6th December 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 selecting **at least TWO from each section**. All questions carry equal marks.

SECTION - A

Question No.1

(a) List the various types of loads to which a beam can be subjected.

(05 Marks)

(b) Draw the shear force and bending moment diagrammes for the beam loaded and supported as shown in Fig.Q1.

Hence determine the maximum bending moment of and the location where it acts on the beam.

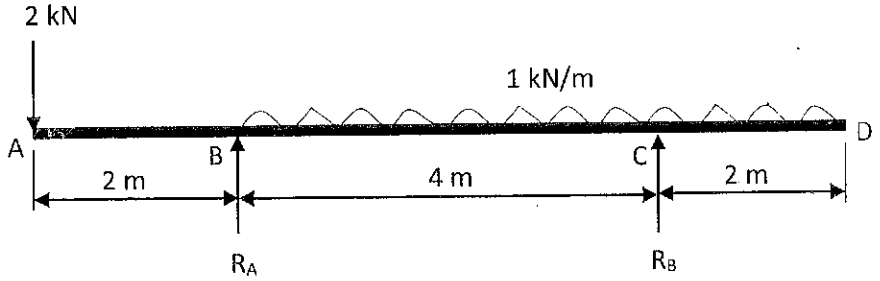


Fig.Q1

(15 Marks)

Question No.2

(a) Define and explain the terms.

i) Longitudinal strain ii) Lateral strain iii) Poisson's ratio

(06 Marks)

(b) A mild steel tube of external diameter 80 mm and internal diameter 60 mm is enclosed centrally inside a brass tube of same length and having external diameter 100 mm and internal diameter 80 mm. The ends of the tubes are brazed together and the composite arrangement is subjected to an axial pull of 25 kN as shown in Fig.Q2.

If modulus of elasticity for steel and brass are 200 GPa and 100 GPa respectively and tube length is 300 mm, determine the load carried by and shortening length or extension of each tube.

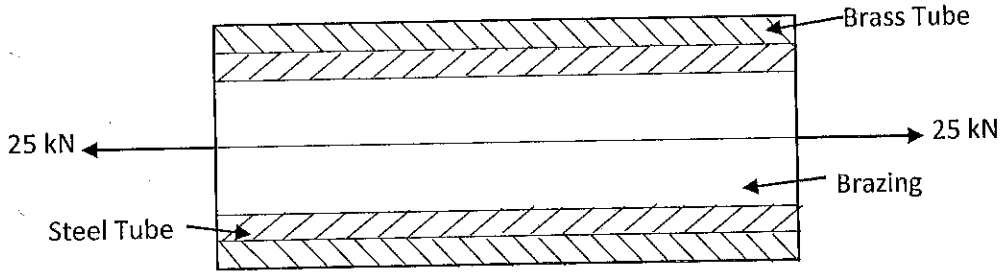


Fig.Q2

(14 Marks)

Question No.3

(a) Explain how Mohr's circle can be constructed for a rectangular stress element subjected to normal stresses σ_x and σ_y shear stress τ ?

(04 Marks)

(b) At a point in a rectangular block of an elastic material under strain, there is a tensile stresses of 50 MPa on one plane and a compressive stress of 30MPa on a plane at right angle to the former. These stresses are accompanied by a shearing stress of 30 MPa. The shear stress acts on the plane carrying tensile stress in such a way that it tends to rotate the block anti-clockwise.

Sketch the block with system of stresses and
determine analytically or graphically the following:
the magnitude of the principal stresses
the direction of the principal planes
the magnitude of the maximum shear stress

(16 Marks)

Question No.4 [Answer TWO Parts from Part (a), (b) & (c)]

(a) Derive the following expression for the ratio of torques transmitted by the hollow and the solid circular shaft of the same material, length and mass.

$$\frac{T_h}{T_s} = \frac{n^2 + 1}{n\sqrt{n^2 - 1}}$$

Where '*n*' is the ratio of outer and inner radii of the hollow shaft and T_h and T_s are the relevant torques on hollow and solid shafts respectively.

Hint: Allowable shear strength is equal for the both conditions.

(10 Marks)

(b) A hollow shaft with an external diameter 'd' and internal diameter 'd/2' is replaced by a solid shaft of diameter 'd'. Find the following:

(i) Ratio of torques transmitted by hollow and solid shafts if equal stresses are induced in the two shafts.

(ii) Maximum shear stress induced in each hollow and solid shaft if the two shafts transmit equal torques.

(10 Marks)

(c) Find the second moment of area about the centroidal axes XX and YY of the section shown in Fig. Q4c.

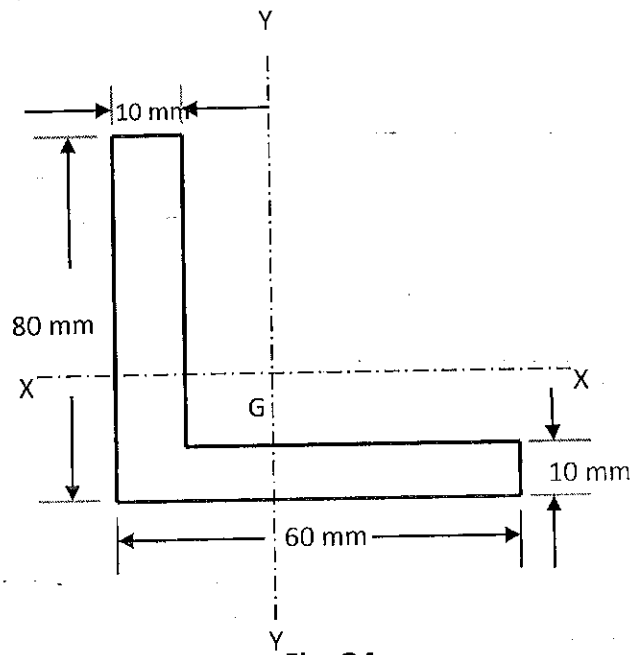


Fig. Q4c

(10 marks)

SECTION - B

Question No.5

(a) For a flat belt, prove that $\frac{T_1}{T_2} = e^{\mu\theta}$,

Where T_1 = Tension in the tight side of the belt,

T_2 = Tension in the slack side of the belt

μ = Coefficient of friction between belt and pulley materials, and

θ = Angle of contact between the belt and the pulley (in radians)

(08 Marks)

(b) Of a flat belt drive, the initial tension is 1,500 N. The coefficient of friction between the belt and the pulley material is 0.3 and the angle of contact between the belt and the smaller pulley is 150^0. The smaller pulley has a radius of 150 mm and rotates at 300 rpm. Find the power in kW transmitted by the belt.

(12 Marks)

Question No.6

(a) If ***I*** is the moment of inertia and **Ω** is the mean speed of a flywheel, prove that the maximum fluctuation of energy can be expressed as

$$E_{max} = \frac{K_s I \Omega^2}{100}$$

Where K_s is the coefficient of fluctuation of speed expressed as a percentage.

(06 Marks)

(b) The turning moment diagram for a petrol engine is drawn with following scales:

Turning moment 1mm = 6 Nm; ***crank angle 1 mm = 1^0.***

The turning moment diagram repeats itself at every half a revolution of the engine and the areas above and below the mean turning moment line taking in order, are +270, -670, +100, -340, +960, -320 mm^2.

The rotating parts are equivalent to a mass of 40 kg at a radius of gyration of 150 mm. Determine the coefficient of fluctuation of speed when the engine runs at 1200 rpm.

(14 Marks)

Question No.7

(a) Explain the advantages over epicyclic gear train over a simple gear train.

(04 Marks)

(b) In an epicyclic gear train shown in Fig.Q7, an arm carries two gears **A** and **B** having 36 and 45 teeth respectively. If the arm rotates at 150 rev/min. in the anticlockwise direction about the center of the gear **A,** which is fixed, determine the speed of gear **B**.

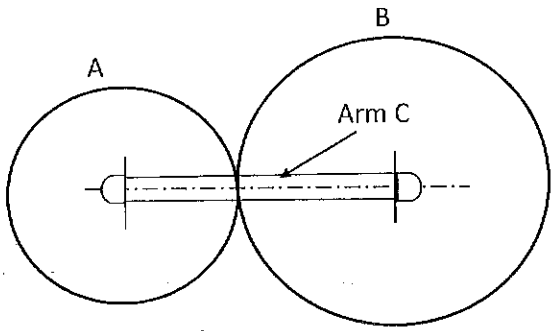


Fig.Q7

If the gear **A**, instead of being fixed, makes 300 rev/min in the clockwise direction, what will be the speed of gear **B**?

(16 Marks)

Question No.8

(a) Why is balancing of rotating parts necessary for high speed reciprocating internal combustion engine?

(05 Marks)

(b) A shaft carries four masses ***P, Q, R*** and ***S*** of magnitude 100 kg, 150 kg, 200 kg and 100 kg respectively and revolves at radii 160 mm, 140 mm, 120 mm and 160 mm in planes measured from ***P*** at 300 mm, 400 mm and 700 mm respectively. The angles between the cranks measured anticlockwise are ***P*** **to** ***Q*** 45^0, ***Q*** **to** ***R*** 70^0 and ***R*** **to** ***S*** 120^0. The balancing masses are to be placed in planes ***X*** and ***Y***. The distance between the planes ***P*** and ***X*** is 100 mm, between ***X*** and ***Y*** is 400 mm and between **Y** and ***S*** is 200 mm. If the balancing masses revolve at radius of 150 mm, find their magnitudes and angular positions.

(15 Marks)

END