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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	:	**DMX4835 Applied Mechanics & Strength of Materials** MEX4335
Academic Year	:	2017/18
Date	:	16th February 2018
Time	:	0930hrs – 1230hrs
Duration	:	3 hours

General instructions

1. Read instructions given below carefully before answering the questions.
2. This question paper has two sections Section A and Section B and eight (08) questions altogether.
3. Answer any 5 questions selecting **at least TWO from each section.**
4. All questions carry equal marks.

SECTION - A

Question No.01:

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

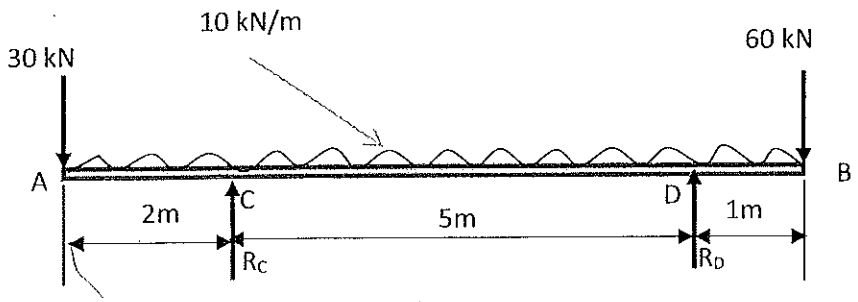


Fig.Q1

Question No.02:

a) Fig.Q2(a) shows a compound bar of length **L**, made up of a rod(r) and 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?

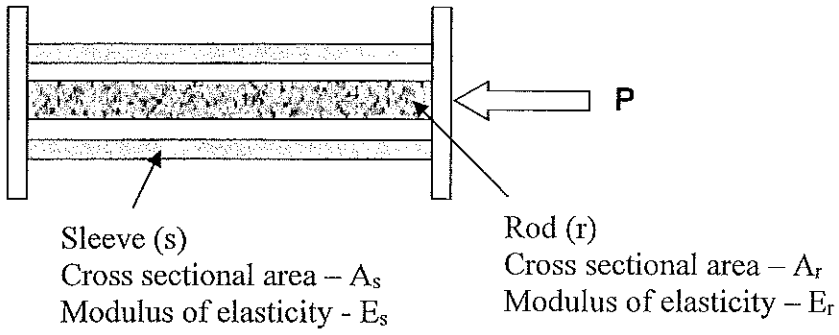


Fig.Q2(a)

b) A concrete column with 1.35 m height is reinforced with six steel bars, each with a diameter of 28 m as in (Fig.Q2(b)). Determine the normal stress in the steel 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.

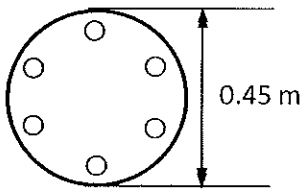


Fig.Q2(b)

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 shear stress of 80MPa.

d) Assuming that the solid shaft has been replaced by a hollow shaft of the same cross-sectional area and with an inner diameter equals 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) 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.Q4(a).

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

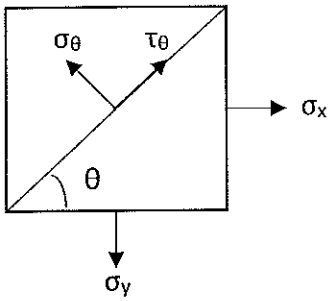


Fig.Q4(a)

b) 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.4(b). Determine the following:

(i) Principal stresses and orientation of the planes on which they act,

(ii) Maximum shear stress and the orientation of the plane where it acts.

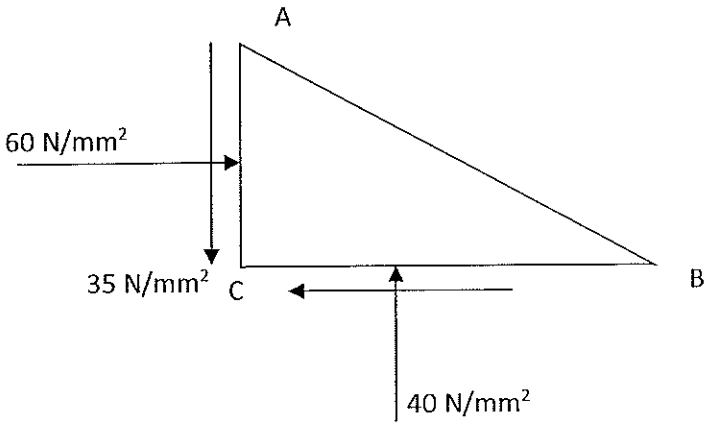


Fig.4(b)

SECTION - B

Question No.05:

a) Write the difference between static balance and dynamic balance. Explain why both conditions have to be satisfied for complete balance.

b) A rotating mass carries four masses A, B, C and D rigidly attached to it. The mass centers are at 32 mm, 38 mm, 41 mm and 35 mm respectively from the axis of rotation. A, C and D have masses 30 kg, 20 kg and 16 kg respectively. The axial distance between A and B is 400 mm and that between B and C 500 mm. The eccentricities of A and C are at 90^0 to one another.
For complete balance, determine:

(i) The angles between
A and B, and
B and D
(ii) The axial distance between the planes of revolution of C and D
(iii) The mass of B

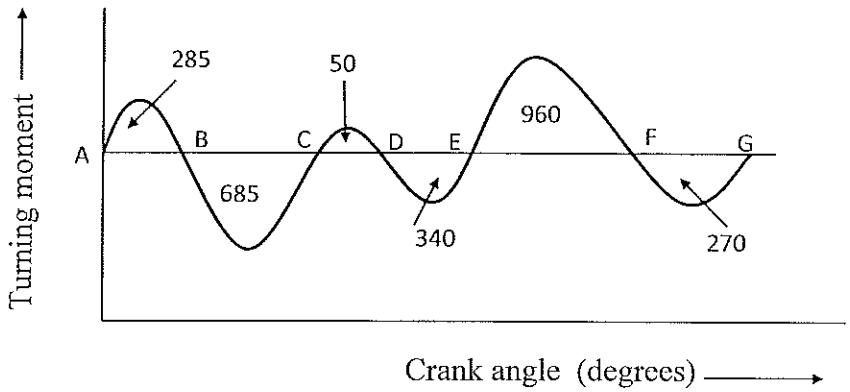
Question No.06:

The turning moment diagram shown in Fig.Q6 repeats in every half revolution of a flywheel, and the areas above and below the mean turning moment line taking in order, are +285, -685, +50, -340, +960, -270 mm^2.

i) Determine the maximum fluctuation of energy.

ii) Find the moment of inertia of the fly wheel, which will keep the speed within the range, 410 to 416 rev/min

iii) If the radius of gyration of the flywheel is 0.5 m, find the mass of the flywheel.



Scales: Turning moment, 1mm ≡ 6 Nm; Crank angle, 1 mm ≡ 1^0

Fig.Q6

Question No.07:

a) Show that the maximum torque transmitted by a single plate clutch (assuming the pressure intensity on the contact faces is uniform) of external and internal radii r_1 and r_2 respectively with limiting coefficient of friction is μ and axial load W is

$$T = \frac{2}{3}\mu W \left[\frac{(r_1)^3-(r_2)^3}{(r_1)^2-(r_2)^2}\right]$$

b) A single plate clutch with both sides effective, has outer and inner diameters 300 mm and 200 mm respectively. The maximum intensity of pressure at any point in the contact surface is not to exceed 0.1 N/mm^2. If the coefficient of friction μ = 0.3, determine the power transmitted by the clutch at a speed 2500 r.p.m.

Question No.08:

a) Explain with a neat an epicyclic gear train.

b) An epicyclic gear train consists of three gears A, B and C as shown in Fig.Q8. The gear A has 72 internal teeth and gear C has 32 external teeth. The gear B meshes with both A and C and is carried on an arm EF which rotates about the center of A at 18 r.p.m. If the gear A is fixed, determine the speed of gears B and C.

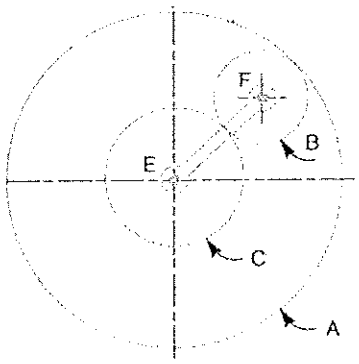


Fig.Q8

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