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	:	**MEX3271 Applied Mechanics and Strength of Materials**
Academic Year	:	2013/14
Date	:	20th August 2014
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. All questions carry equal marks.
3. Answer any 5 questions selecting **not more than THREE** from each section.

SECTION- A

Question 1:

a) Define a composite bar.

b) A rod whose ends are fixed to rigid supports is heated so that rise in temperature is T^0C. Prove that the i) thermal strain = $\alpha.T$, and ii) thermal stress = $\alpha.T.E$, where α is the co-efficient of linear expansion of rod material.

c) A steel tube of 50 mm external diameter and 40 mm internal diameter enclosed a brass rod of 35 mm diameter. The rod and the tube are rigidly joined together at each end. If at a temperature of 20^0 C there is no longitudinal stresses, calculate the stresses induced in the rod and tube when the temperature is raised to 200^0 C. Take Young's Modulus of steel and brass as $2.1x10^5$ N/mm^2 and $1.2\ x10^5$ N/mm^2 respectively. The value of coefficient of linear expansion for steel and brass is given as $13x10^{-6}$ / ^{0}C and $18x10^{-6}$ / ^{0}C respectively.

Question 2:

a) Derive an expression for the stresses on an oblique plane of a rectangular body, when the body is subjected to a simple shear stress.

b) At a point in a strained material, on plane ***BC*** there are normal and shear stresses of 640N/mm^2 and 160 N/mm^2 respectively. On plane ***AC***, which is perpendicular to ***BC***, there are normal and shear stresses of 320 N/mm^2 and 160 N/mm^2 respectively. These stresses are shown in Fig.Q2. Determine the following:

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

(ii) Maximum shear stress and the plane on which it acts.

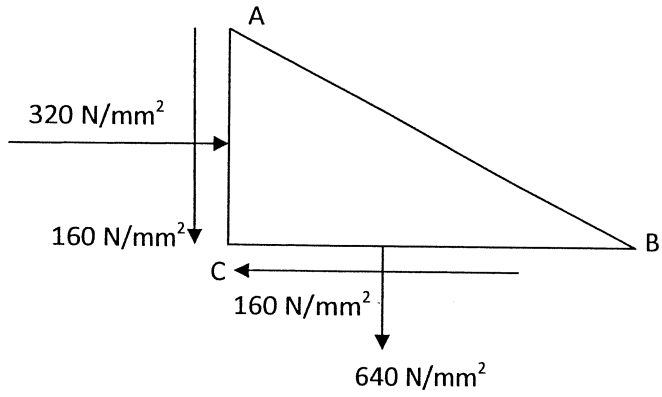

Fig.Q2

Question 3:

a) Show that $I_o = I_G + Ah^2$.

Where I_G is the second moment of area of a cross section with area **A** about an axis through the centroid, and **h** is the distance from the centroid to a parallel axis in the same plane about which its second moment of area is I_o.

b)

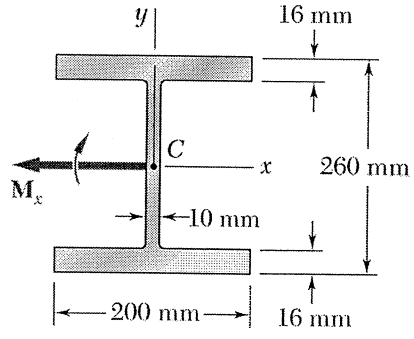

Fig.Q3

The steel beam shown in Fig.Q3, is made of steel for which yield strength (σ_y) = 250 MPa and ultimate tensile strength (σ_u) = 400 MPa. Using a factor of safety of 2.50, determine the largest couple $\underline{M_x}$ that can be applied to the beam when it is bent about the x axis.

Question 4:

a) Briefly explain with relevant sketches the different types of beams and different types of loads acting on a beam.

b) What are the accepted sign conventions for shear forces and bending moments adapted in drawing shear force and bending moment diagrammes?

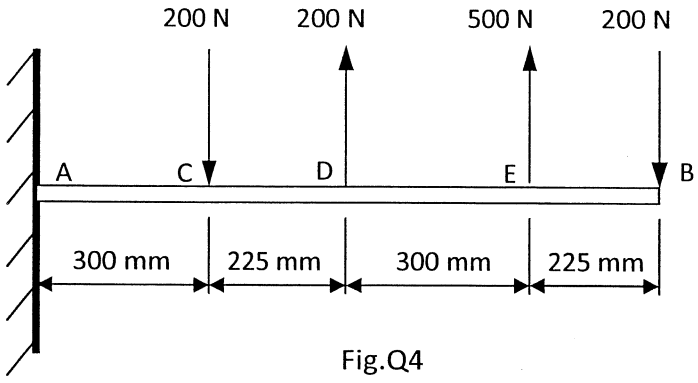

Fig.Q4

c) For the beam and loading shown in Fig.Q4,

i) draw the shear force and bending moment diagrammes indicating the critical values, and

ii) determine the maximum value of the Shear force and bending moment.

SECTION- B

Question 5:

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

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.

Question 6:

The turning moment diagram of a double acting steam engine, indicated its maximum value of 2500 Nm during the forward stroke of the piston when the crank makes an angle of 80^0 with the inner dead center (IDC). During the backward stroke, the maximum turning moment is 2000Nm when the crank makes an angle of 80^0 with the outer dead center (ODC). For the simplicity the turning moment diagram for the engine may be assumed to be represented by the two triangles.

a) Sketch the turning moment diagramme.

If the crank makes 250 rpm and the radius of gyration of the flywheel is 2.0 m,

b) find the coefficient of fluctuation of energy and the mass of the flywheel to keep the speed within ±0.75% of the mean speed.

c) determine the crank angle at which the speed has its minimum and maximum value.

Question 7:

a) A block of weight W lies on a plane inclined at an angle α to the horizontal. Prove that the magnitude of a horizontal force H required to slide the block directly up the plane without acceleration is

$H = W \tan(\alpha + \lambda)$ where λ is the friction angle between the block and the plane.

b) A conical pivot bearing supports a vertical shaft of 300 mm diameter. It is subjected to a load of 50 kN. The angle of the cone is 120^0 and the coefficient of friction is 0.03. Find the power lost in friction when the speed is 150 r.p.m., subjected to following conditions.

i) Uniform pressure

ii) Uniform wear.

Question 8:

a) What is epicyclic gear system?

b) Explain a popular practical application of epicyclic gear system.

c)

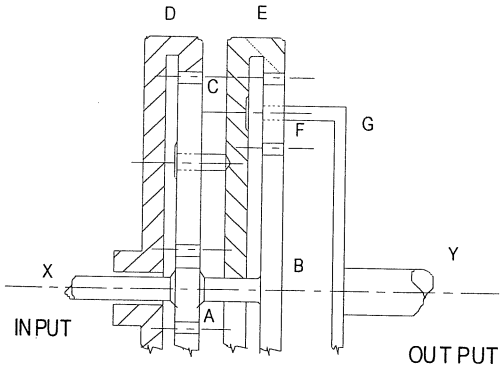

Fig.Q8

A compound epicyclical gear train is shown in Fig. Q8. , The wheels A and B are integral with the input shaft X. Planet wheel C rotates on a pin carried by the annular wheel E and planet wheel F rotates on a pin attached to arm G, which is keyed to the output shaft Y.
The number of teeth on each wheel is as follows:

A – 20, B – 50, D – 100 and E – 100.
Find the overall gear ratio when the annulus D is fixed.

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