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	:	2012/13
Date	:	07th August 2013
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 01:

a) Define briefly the terms ***principal stress*** and ***principal plane*** in two dimensional stress analysis.

(06 marks)

b) A point is subjected to perpendicular tensile stresses of magnitude 50 MN/m^2 and $30MN/m^2$. Calculate the normal stress, tangential stress and the resultant stress and its obliquity on a plane making an angle of 30^0 with the axis of second stress using an analytical method or a graphical method.

(14 marks)

Question 02:

A beam AB 10m long carries a uniformly distributed load 20 kN/m over its entire length together with concentrated load of 50 kN at the left end **A** and 80 kN at the end **B**(Fig.Q2). The beam is to be supported at two props at the same level 6m apart, so that the reaction is same at each. Determine the positions of the supports and draw the Shear Force and Bending Moment diagrams. Find the value of the maximum Bending Moment. Locate the point of contraflexture, if any.

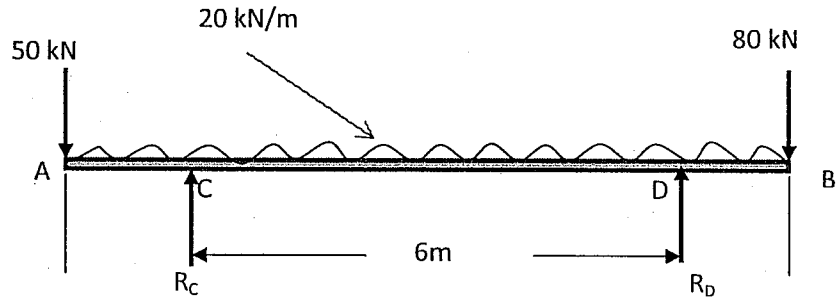


Fig.Q2 ***(20 marks)***

Question 03:

a) State the parallel axis theorem.

(05 marks)

b) Find the moments of inertia about the centroidal axes XX and YY of the section shown in Fig. Q3.

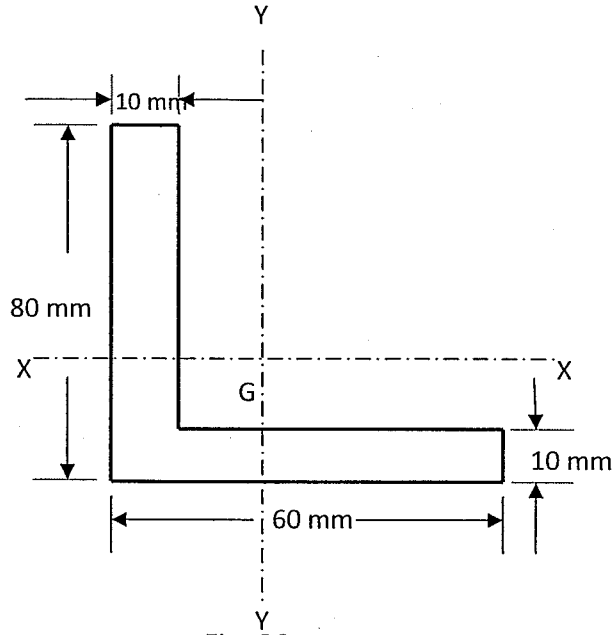


Fig. Q3 ***(15 marks)***

Question 04:

A compound bar(Fig.Q4) is made up of a central steel strip 40 mm wide and 5 mm thick placed between two strips of brass each 40 mm wide and ***'x'mm*** thick.The strips are firmly fixed together to form a compound bar of rectangular section 40 mm wide and (2x+5)mm thick.

Determine:

(i) The thickness of the brass strips which will make the apparent modulus of elasticity of the compound bar equal to $160x10^3$ MN/m^2.

(14 marks)

(ii) The maximum axial pull the bar can then carry if the stress is not to exceed 160 MN/m^2, in either the brass or the steel.

Take: E_s = 207 GN/m^2 and E_b = 114 GN/m^2

(06 marks)

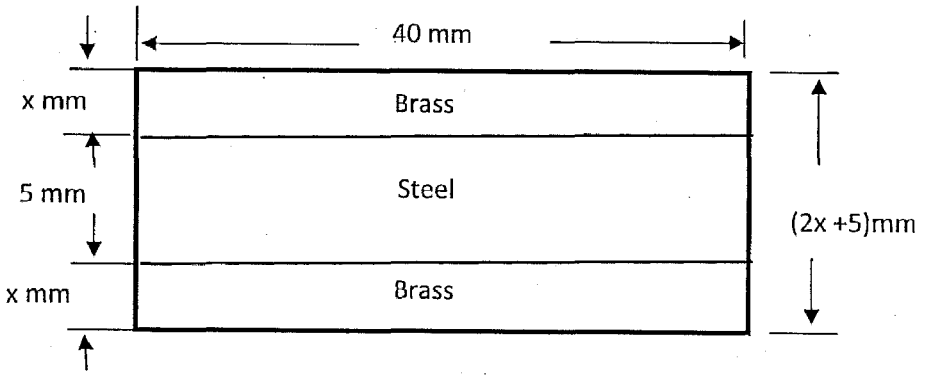


Fig.Q4

SECTION B

Question 05:

a) What are the requirements for complete balance of a system?

(05 marks)

b) A line shaft carries four rotors *A,B, C* and *D* each 200 mm apart. Out of balance force produced by the rotors *A, B* and *C* are 600N, 1000N and 500N respectively at the shaft speed of 500 rev/min. If the shaft is dynamically balanced, find the directions of the out of balance forces relative to the rotor *A*. Also determine the out of balance force produced by rotor *D*.

(15 marks)

Question 06:

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

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

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

(06 marks)

b) The turning moment diagram for one revolution of a multi cylinder engine shows the following intercepted areas in mm^2 above and below the load torque line :

-20, +58, -35, +58, -55, +40, -57, +64, -36

The vertical and horizontal scales are 1mm represent 1000Nm and 5^0 respectively. If the mean speed is 500 rev/min and the overall fluctuation of speed is not to exceed 1.5%, determine the moment of inertia of the flywheel.

(14 marks)

Question 07:

a) Give three advantages of epicyclic gear systems over the other gear systems.

(06 marks)

b) Two shafts **A** and **B** are co-axial. A gear **C** (50 teeth) is rigidly mounted on shaft **A**. A compound gear **D-E** meshes with **C** and an internal gear **G**. **D** has 20 teeth and meshes with **C** and **E** has 35 teeth and meshes with an internal gear **G**. The gear **G** is fixed and is concentric with the shaft axis. The compound gear **D-E** is mounted on a pin which projects from an arm keyed to the shaft **B** as shown in Fig.Q7.

(I) Find the number of teeth on internal gear **G** assuming that all gears have the same module.

(04 marks)

(ii) If the shaft **A** rotates at 110 r.p.m. , find the speed of shaft **B**

(10 marks)

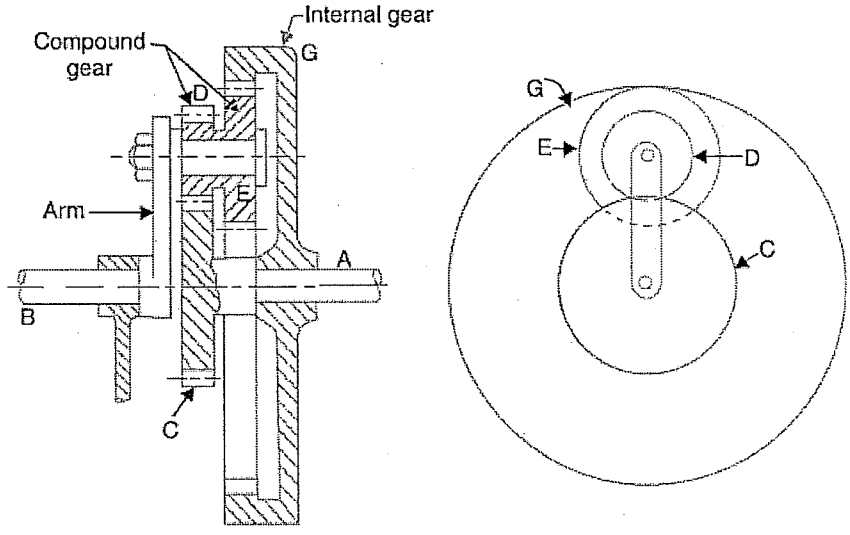


Fig.Q7

Question 08:

a) A single plate friction clutch, with two sides of the plate effective, transmits 50kW at 1500rev/min. The coefficient of friction is 0.3. If there is a uniform plate pressure of $p = 50kN/m^2$, and the inner radius is 0.6 times the outer radius, calculate the axial force required.

After the clutch has been in use for some time, conditions of uniform wear occur. What would then be,

(i) the maximum plate pressure and
(ii) power transmitted for the axial force?

(14 marks)

b) (i) State the difference between the terms, over damping and under damping.

(ii) What is meant by natural frequency of a system?

(iii) Define degree of freedom of a vibrating system.

(06 marks)

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