Registration No. : | | | | | | | | | | |

Total number of printed pages – 3

B. Tech

PCME 4202

Third Semester Back Examination – 2014

MECHANICS OF SOLIDS

BRANCH(S) : AUTO, CIVIL, MECH, MINERAL, MINING

QUESTION CODE : L 327

Full Marks – 70

Time : 3 Hours

*Answer Question No. **1** which is compulsory and any **five** from the rest.*

The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2×10

   (a) Define the principle of superposition and explain its significance.

   (b) Define the equilibrium and compatibility equations of the compound bars.

   (c) Define the term factor of safety and explain its importance.

   (d) Derive a relation between Young's modulus, Poisson's ratio and modulus of rigidity.

   (e) What is Mohr's stress circle ? How is it useful in the solution of stress analysis problems ?

   (f) What do you mean by statically indeterminate beams ? Explain.

   (g) What do you mean by point of contra-flexure ? Explain.

   (h) Explain and draw different types of beams with end conditions.

   (i) How do you distinguish between thin and thick pressure shells ?

   (j) What is Euler's curve ? What is its importance ?

2. (a) Calculate the total elongation of the steel bar ABCD as shown in the figure having a cross-sectional area 'A' = 650 mm^2 and subjected to forces. Take E = 210 GPa 5

P.T.O.

(b) A rigid bar ECD as shown in the figure is kept in a horizontal position by two vertical rods, one of brass and other of steel. The steel rod has a length of 3m and a diameter of 20mm. The brass rod has a length of 2m and diameter of 30 mm. Find the position of the load 'P' so that the bar remains horizontal. $E_s = 200GPa$ for steel and $E_b = 100$ GPa for brass. 5

3. (a) Three rods, each 25mm, support a weight of 10kN as shown in the figure. The outer rods are of aluminum and central rod is of steel. $E_s = 200$ G Pa for steel and $E_a = 70$ GPa for aluminum. Find the stress in the rods. Length of steel rod = 2m. 5

(b) A steel rod 25mm diameter pass through a brass tube of 25 mm internal diameter and 35mm external diameter. The nut on the rod is tightened until a stress of 10 $\frac{N}{mm^2}$ is developed in the rod. The temperature of the tube is then raised by 60°K . What are the final stresses in the rod and tubes ? 5

$E_s = 200 \frac{kN}{mm^2}$, $E_b = 80 \frac{kN}{mm^2}$

$\alpha_s = 0.0000117$ per °K, $\alpha_b = 0.000019$ per °K,

4. At a point in a piece of elastic material, there are three mutually perpendicular planes, on which the stresses are as follows : 10

A normal tensile stress of $50 \frac{N}{mm^2}$ and a shear stress of $40 \frac{N}{mm^2}$ on one plane, a normal compressive stress of $35 \frac{N}{mm^2}$ and the complementary shear stress of $40 \frac{N}{mm^2}$ on a second plane and no stress on the third plane. Determine:

(i) The principal stresses at the point and the position of the planes on which they act

(ii) The position of the planes on which there is no normal stress

(iii) Draw the Mohr's circle

5. A beam with one overhang is loaded and supported as shown in the figure. Construct the S.F. and B.M. diagrams. 10

6. A beam of 9m span supports a 160mm thick concrete wall. The height of the wall is 1m at the left end and increases to 2m at the right end. The beam has two supports, one at 2m from the left end and the other at 1m from the right end. Find the maximum bending moment on the beam if the concrete weighted 25 $\frac{kN}{m^2}$. Draw the S.F. and B.M. diagrams. 10

7. (a) Determine the strain energy of a cantilever with uniformly distributed load. Also find the deflection of the free end. 5

(b) A vertical strut 6m long, hollow circular in section with external diameter 100mm has pinned ends. It deflects by 50mm when a central point load of 3075 kN is applied on it in a horizontal direction. Determine the crippling load on the columns. E = 200GPa, determine the thickness of the section. 5

8. (a) A spherical steel vessel having an internal diameter of 600mm and a wall thickness of 10 mm is filled with water under a pressure of $\frac{5MN}{mm^2}$. The pressure is reduced gradually by letting out some water. To reduce the pressure to atmospheric, the volume of water let out is $375 \cdot 10^2 mm^2$. If the bulk modulus of water is $\frac{2GN}{m^2}$ and $E_s = 200\frac{GN}{m^2}$, calculate Poisson's ration. 6

(b) Compare the weights of equal lengths of a solid and a hollow shaft to transmit a given torque for the same maximum stress if the inside diameter of the shaft is three times of the outside diameter. 4