Ex/BESUS/AM-401/07

B.E. (CE) Part-II 4th Semester Examination, 2007

Solids Mechanics-II (AM-401)

Time : 3 hours **Full Marks : 70**

Use separate answerscript for each half.
Answer SIX questions, taking THREE from each half.
Two marks are reserved for neatness in each half.

FIRST HALF

1. At a point in a vertical cross section of a beam there is a resultant stress of 50 MPa, which is inclined upward at 35^0 to the positive direction (towards right) of the horizontal axis. On the horizontal plane through the point there is only shearing stress. Find the resultant stress on the plane which is inclined at 40^0 to the vertical and 95^0 to the given resultant stress, both in magnitude and in direction with respect to the horizontal. (11)

2. A spherical steel vessel has a diameter of 1.0m and the thickness of the shell is 10mm. Find the internal hydraulic pressure required to produce a stress of 70 N/mm^2 in the material. What additional volume of water must then be pumped in to produce the stress to 85 N/mm^2? Assume $E = 21x\ 10^4\ N/mm^2$, $K = 2100\ N/mm^2$ and $\mu = 0.3$. (11)

3. A flywheel having a mass of 600 kg. is mounted on a shaft 0.08 m. in diameter and midway between bearings 0.6 m. apart, in which the shaft may be assumed to be directionally free. If the shaft is transmitting 30 kW at 360 r.p.m., calculate the principal stresses and maximum shearing stresses in the shaft at the ends of a vertical and a horizontal diameter in a plane close to that of the flywheel. (11)

4a. A thin cylindrical shell 2.5 m. in diameter is composed of plate 12.5 mm. Thick. The yield stress of the material is 300 MPa. Calculate internal pressure which would cause yielding according to the following theories of failure (a) Maximum principal stress, (b) Maximum shear stress (c) Maximum strain energy, (d) Maximum shearing strain energy. $\mu = 0.28$.

4b. The rim of a flywheel of weight W and mean center line radius r is attached to a hub by four spokes as shown in Fig. Q4b. Each spoke has a rectangular cross section of dimensions b x h and a length l. The spokes are built in at the hub and pinned at the rim. While the wheel rotates with constant angular velocity ω, the hub is suddenly locked. What maximum bending stress will be induced in each spoke where it joints the hub ? Neglect the weight the spokes. (7+4)

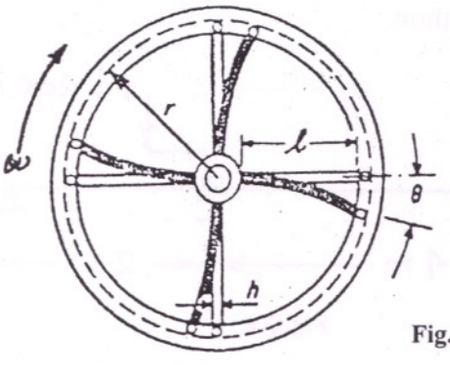

Fig.Q.4b

5. A simply supported beam AB carries a triangularly distributed load as shown in Fig. Q5. Find the equation of deflection curve and maximum deflection. (11)

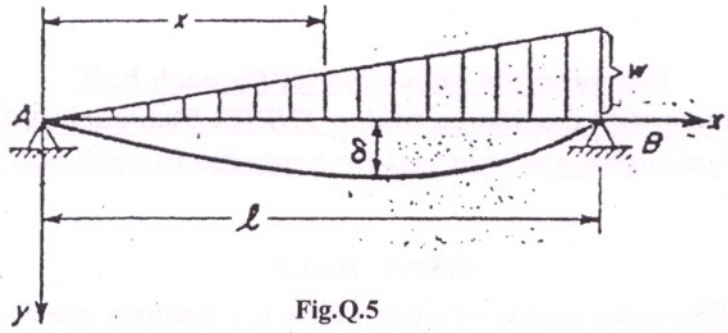

Fig.Q.5

SECOND HALF

(*The questions are of equal value.*)

6. a) State Castigliano's theorem as used in finding deflection of structures. Discuss its limitations.

   b) A thin circular steel ring of mean radius R = 7.5 cm has a 0.5 cm by 0.5 cm square cross-section and is cut through at one point on its circumference. A 0.5 cm thick block is then inserted in the gap after the ring is spread open. Calculate the maximum bending stress produced in the ring.

   Given $E = 2.0 \times 10^5$ N/mm^2.

7. a) Starting from the first principles, deduce the critical load for a long column with both ends fixed, the load being applied axially to the column.

   b) Find Euler's critical load for a hollow cylindrical cast iron column 200 mm external diameter and 25 mm thick, if it is 6 m long and hinged at both ends. Compare this load with Rankine's critical load.

   Given $E = 8.0 \times 10^4$ N/mm^2, $\sigma_c = 550$ N/mm^2 and $\alpha = \frac{1}{1600}$.

8. A beam of length 6 m is loaded as shown in Fig.Q.8. Find the deflection of the point C in mm by using any suitable method.

   Given EI = 40000 kN-m^2.

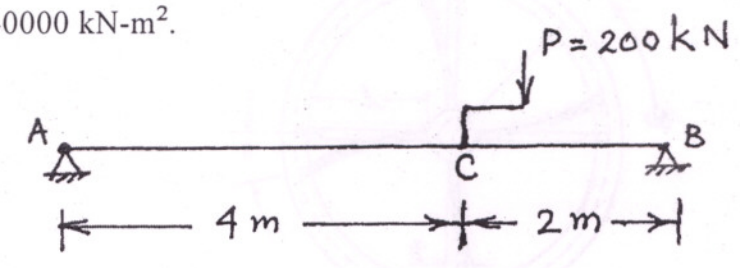

Fig.Q.8

9. A beam has a rectangular cross-section 40 mm (width) x 90 mm (depth). A couple of 180 N-m is applied at one section forming an angle of 30° with the vertical as shown in Fig.Q.9. Determine the maximum tensile stress and the location where it occurs. Also find the angle which the neutral axis makes with the horizontal plane. Sketch the neutral axis.

(Note : The moment is applied in the plane 1-1 and the direction of corresponding vector is shown in the figure)

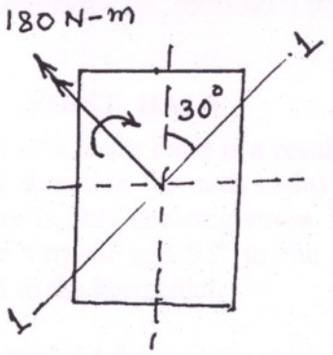

Fig.Q.9

10. a) Define : degree of freedom, periodic motion, vibration and oscillation.

b) Calculate the natural frequency and natural period of vibration for the sidesway of the frame shown in Fig.Q.10.

If the initial displacement and initial velocity is 30 mm and 30 mm/sec respectively, what is the amplitude and displacement at t = 1 sec?

Given $(EI)_{AB} = 20 \times 10^{12}$ N-mm^2 and $(EI)_{CD} = 12 \times 10^{12}$ N-mm^2.

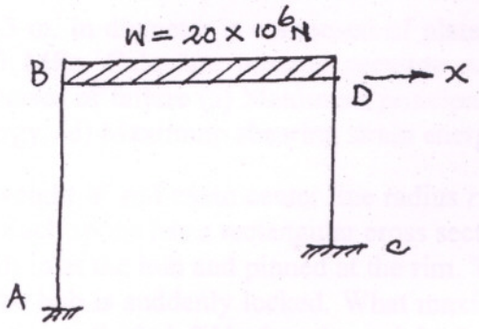

Fig.Q.10

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