B.E. MECHANICAL ENGINEERING FIRST YEAR SECOND SEMESTER EXAM 2019 (Old)
ENGINEERING MECHANICS - II

Time: Three Hours **Full Marks: 100**

Any missing data may be assumed with suitable justification
PARTS OF THE SAME QUESTION MUST BE ANSWERED TOGETHER

ANSWER ANY FIVE QUESTIONS

Q1. **[12+8]**

(a) Find the stresses developed in the two wires *CD* and *BD* supporting a rigid bar *ACB* as shown in **Fig. Q1a.** The bar is hinged at end *A*. Assume further that the wires are identical and each has cross-sectional area = 100 mm^2.

(b) Prove that stress distribution for uniaxial loading of a member will be uniform if the line of action of the external load passes through the centroid of the cross-section of the member.

Q2. **[10+10]**

(a) A hollow shaft is to transmit 250 kW at a frequency of 30 Hz. Knowing that the shearing stress must not exceed 50 MPa, calculate the diameters of the shaft for which the ratio of the inner diameter to the outer diameter is 0.75.

(b) Compute the maximum shear stress developed in a close-coiled helical spring having mean coil diameter of 200 mm and consisting of 30 turns of 20 mm diameter wire when the spring is stretched 100 mm. Take G = 40 GPa.

Q3. **[12+8]**

For the rectangular cross section beam loaded as shown in **Fig. Q3**, draw the shear force and bending moment diagrams, neatly marking all the important points and the corresponding values.

Also determine the height h of the beam cross section, knowing that σ_{all} =20 MPa and τ_{all} =8 MPa.

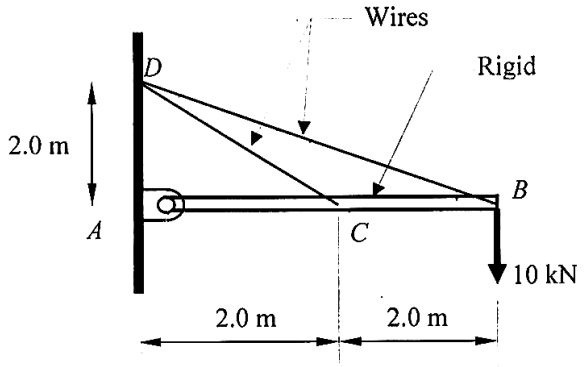

Fig. Q1a

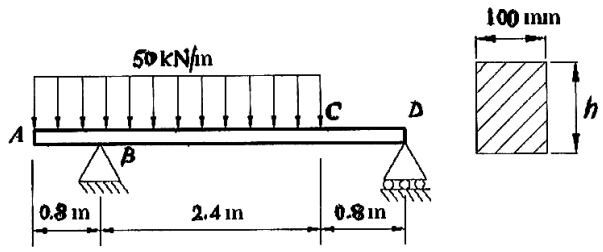

Fig. Q3

Q4. **[12+8]**

(a) A 45^0 strain rosette gives the following data: ε_a= 670×10^{-6}, ε_b=330×10^{-6} and ε_c=150×10^{-6}. Find the principal stresses. Use E= 200 GPa and v=0.3.

(b) For a thin-walled pressure vessel having wall thickness t and subjected to internal pressure p, deduce the governing equation $\frac{\sigma_1}{r_1}+\frac{\sigma_2}{r_2}=\frac{p}{t}$, relating the principal stresses. The symbols carry their usual meanings.

Q5. |10+10|

(a) **Fig. Q5a** shows a differential bi-axial stress element. (i) Find the principal stresses and the orientations of the principal planes and show the results on a rotated differential element, (ii) Find the maximum shear stress and its plane of occurrence

(b) Compute the final velocities v_1' and v_2' after collision of the two cylinders (**Fig. Q5b**) which slide on the smooth horizontal shaft. The coefficient of restitution is $e = 0.6$.

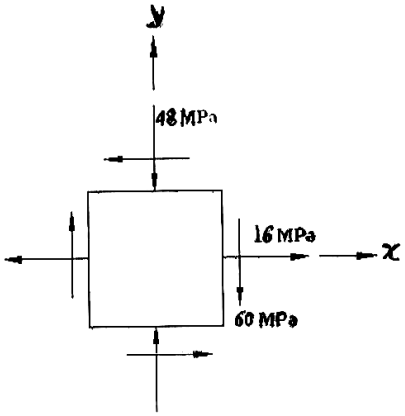

Fig. Q5a

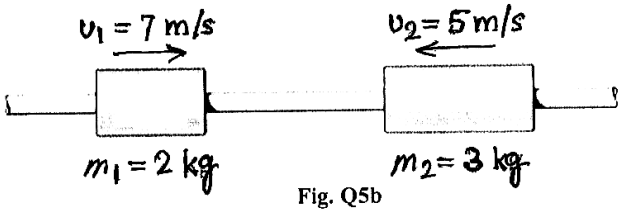

Fig. Q5b

Q6. |10+6+4|

(a) After launch from the earth, the 85000-kg space-shuttle orbiter is in the elliptical orbit as shown in **Fig. Q6a**. If the orbit is to be circularized at the apogee altitude of 320 km, determine the necessary time duration during which its two orbital-maneuvering system (OMS) engines, each of which has a thrust of 30 kN, must be fired when the apogee position C is reached.

(b) Show that the vertical shear stress in a beam with rectangular cross section varies parabolically over the depth of the section.

(c) What do you mean by damped natural frequency? Briefly explain.

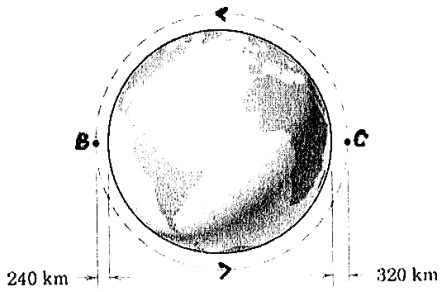

Fig. Q6a

Q7. |5×4 = 20|

(a) What do you mean by pure bending of beam?

(b) Draw and explain the stress-strain diagram of mild steel.

(c) What do you mean by "point of contra-flexure"? Explain with neatly drawn sketch.

(d) What do you mean by central force motion? Explain with examples.