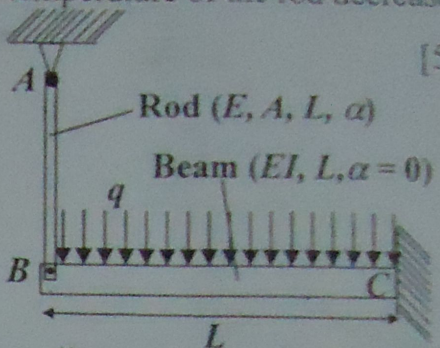
Indian Institute of Technology Delhi

Minor II: Second Semester: 2014-15

Course: Mech. of Solids and Fluids, APL105 **Date:** 22 March 2015 **Dur.:** 1 Hr (1.00-2.00 PM)

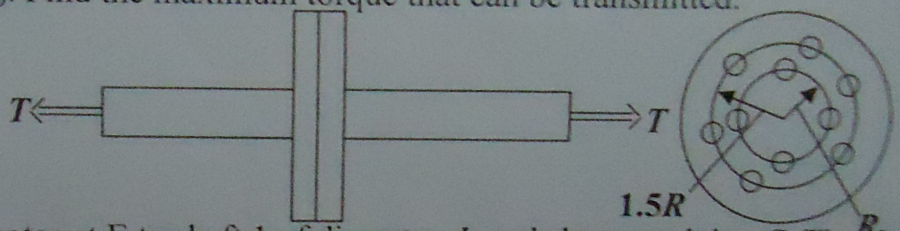
Note: Answer all the questions. Marks are indicated against each question.

Q. 1: A steel rod of length L and cross-sectional area A is pinned to the cantilever beam loaded as shown. Determine the deflection of end B of the cantilever if the temperature of the rod decreases by ΔT and beam is subjected uniformly distributed load of q N/m^2. [5]

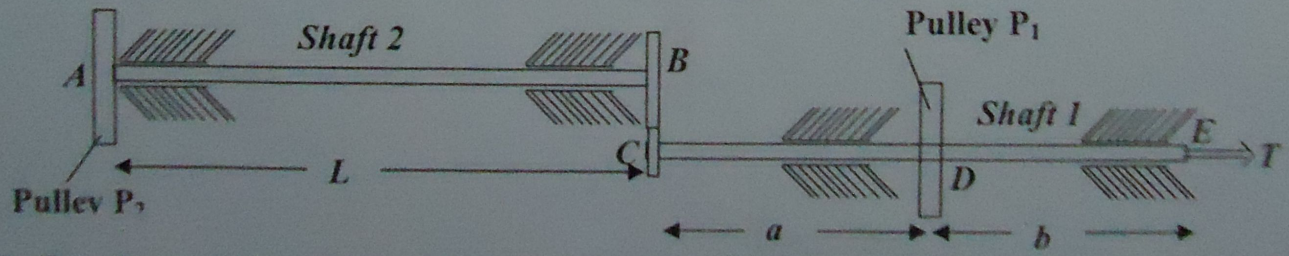


For cantilever beam of length L with concentrated force P at its free end: $v_{max} = PL^3/3EI$ and under uniformly distributed load: $v_{max} = qL^4/8EI$.

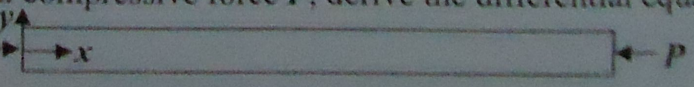
Q. 2: Two shafts of diameter d each are coupled by a flange coupling with **four bolts** at pitch circle radius R and **six bolts** at pitch circle radius $1.5R$. The allowable shear stress in the shafts is τ_s and in the bolt is τ_b. The bolt diameter is d_b. Find the maximum torque that can be transmitted. [7]



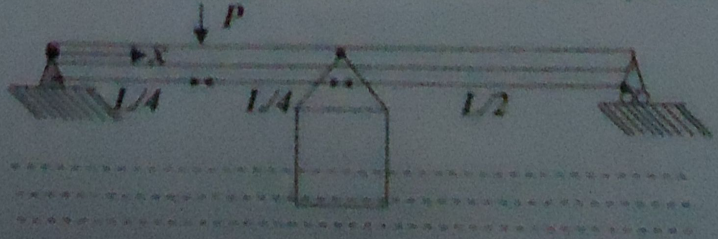
Q. 3: A torque T is input by a motor at E to shaft 1 of diameter d_1 and shear modulus G. The shaft 2 has diameter d_2 and shear modulus G. The output torque through pulley P_1 is $T/2$ and pulley P_2 is fixed. The ratio of diameters of gears at B and C is 4. Derive the expressions for: (a) maximum torsional shear stress in each shaft, (b) relative rotation of end E with respect to end A. [12]



Q. 4: For a beam subjected to axial compressive force P, derive the differential equation for deflection (v) in buckled configuration. [6]



Q. 5: A simply-supported beam of flexural rigidity EI is supported by a pontoon at its centre and loaded as shown. The pontoon has area of cross-section A at the water-line (water density = ρ). Find the deflection of centre of the beam. Before the application of force P, the system is in equilibrium in the configuration shown. [15]



Q6 In a flow field the fluid velocity is given by $V = 2t\,i + xyt^2\,j$

a) Find the equation of streamline passing through (0,1) at time t.

b) Find the equation of the pathline of a particle passing through (0,1) at t=0.

c) Find the equation of streakline observed at t = 5 for particles passing through (0,1) at time τ, where $0 \le \tau \le 5$.

(You can leave the equations in parametric form). (10 marks)

Q7. A slider bearing of length L consists of a block moving on a flat surface with a thin layer of viscous fluid of coefficient of viscosity μ between the two surfaces. The block is inclined and the equation of the surface is given by $h = h_0 + \alpha x$, where h_0 and α are constants. If the slider moves with a constant speed U, find the force required to hold the bottom surface from moving. The width (dimension of the block perpendicular to paper) is w.

(5 marks)