DEPARTMENT OF APPLIED MECHANICS
MAJOR TEST (I –SEMESTER, 2006-2007)
AML110: MECHANICS

Time allowed: 2 hour
Maximum Marks: 80

Answer all the questions. Each question carries 10 Marks. Take g = 9.81 m/sec²

Q. 1. For the structure shown in **Fig 1**, determine the force in the cable EF.

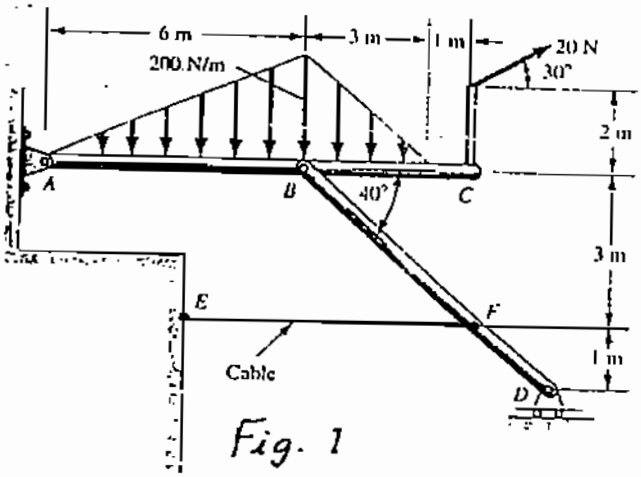


Fig. 1

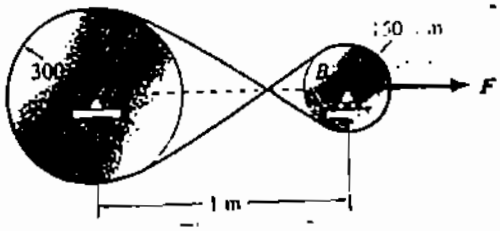


Fig. 2

Q. 2. What minimum force F is needed so that drum *A* (Fig. 2) can transmit a clockwise torque of 700 N-m without slipping? The coefficient of friction between A and the belt is 0.7. What minimum coefficient of static friction is needed between drum B and belt for no slipping?

Q. 3. A flyball governor has **(Fig 3)**the following data at the instant of interest:

$\omega = 0.2$ rad/sec; $\dot{\omega} = 0.04$ rad/sec^2; $\alpha = 45^0$;

$\omega =$ $\dot{\alpha} = 5$rad/sec; $\ddot{\alpha} = 0.2$ rad/sec

If at this instant, the arms are in the xz plane, give the velocity and acceleration vectors of the sphere A using cylindrical coordinates for the axial, transverse and radial directions.

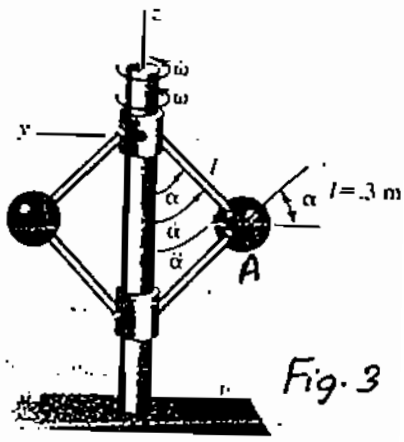


Fig. 3

Q. 4. A square-threaded screw has a diameter of 50 mm and is inclined 45^0 to the horizontal as shown in **Fig 4**. The pitch of the thread is 5 mm, and it is single-threaded. A body *A* weighing 290 N and having a radius of gyration of 300 mm screws onto the shaft. A torque *T* of 45 N-m is applied to *A* as shown. What is the angular speed of A after three revolutions starting from a rest configuration? Neglect friction.

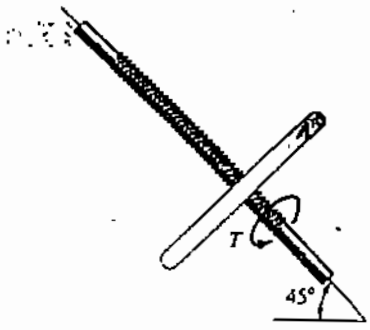


Fig. 4

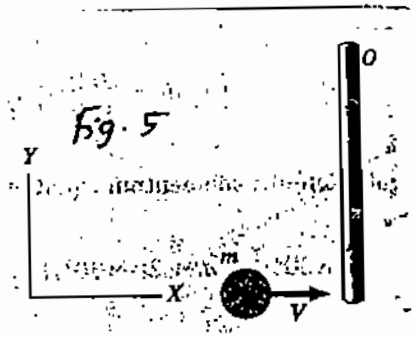


Fig. 5

Q. 5. A 22-N sphere moving at a speed of 10 m/sec hits the end of a 1-m rod having a mass of 10 kg **(Fig 5).** The coefficient of restitution for the impact is 0.9. What is the post-impact angular velocity of the rod if it is stationary just before impact? The rod is pinned at O.

Q. 6. The special-purpose fan is mounted as shown in **Fig 6.** The motor armature, shaft and blades have a combined mass of 2.2 kg with radius of gyration of 60 mm. The axial position b of the 0.8 kg block A can be adjusted. With the fan turned off, the unit is balanced about the X – axis when b = 180 mm. The motor and fan operate at 1725 rev/min in the direction shown. Determine the value of b that will produce a constant angular speed of 0.2 rad/sec about the positive y axis.

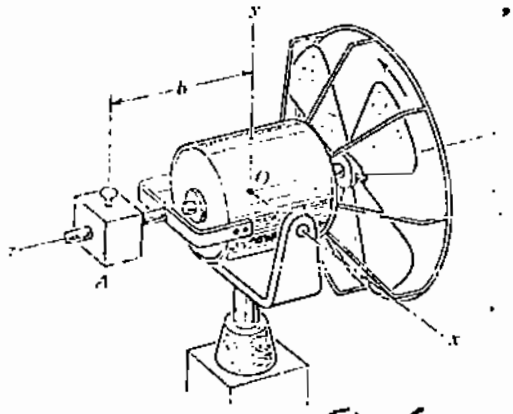


Fig. 6

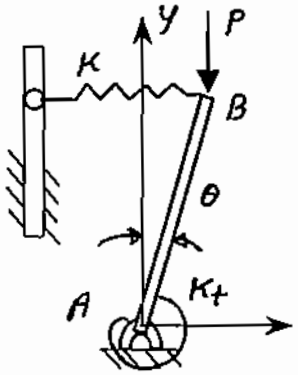
Q 7) a) State the conditions for balancing a body that is constrained to rotate about a fixed axis (say z axis). (2)

b) A light rod AB (of length L) is hinged at A and connected to a linear spring (of constant k) which is always horizontal as shown. At the hinged end a torsional spring is connected (of constant k_t). A constant vertical load P acts at B. Both the springs are un-deformed for θ=0. (Note: the energy stored in a torsional spring for an angular deflection θ is ½ k_t θ^2).

i) Write the expression for the combined potential energy V(0).

ii) Derive the condition that the equilibrium configuration(s) must satisfy and show that θ = 0 is an equilibrium configuration.

iii) Discuss the stability of the equilibrium at θ = 0.



(8)

Q 8) A thin uniform rod of mass per unit length, λ, is welded to a light vertical rod that ean rotate about a fixed vertical axis. An external torque M_O acts on the vertical shaft and makes the system rotate at angular speed ω and angular acceleration $\dot{\omega}$ as shown. Determine the force $\bar{F}_O$ and the couple $\bar{C}_O$ acting at a section just to the left of O as shown. Hence determine the axial force, shear force, twisting moment and bending moment at that section. (10)