DEPARTMENT OF APPLIED MECHANICS

Engineering Mechanics: AML-110

Semester-II: Session-2008-2009

Major Test

Time: 2 hr
Max. Marks: 100

Note:

1. Answer **any six** questions. All questions carry equal marks.
2. Write your answer in the same booklet and submit.
3. At the end of each question you attempt, list the important answers.
4. This document has **34 pages**.

Name.....

Entry No.....

Group No.....

Q. No.	Marks

Total.....

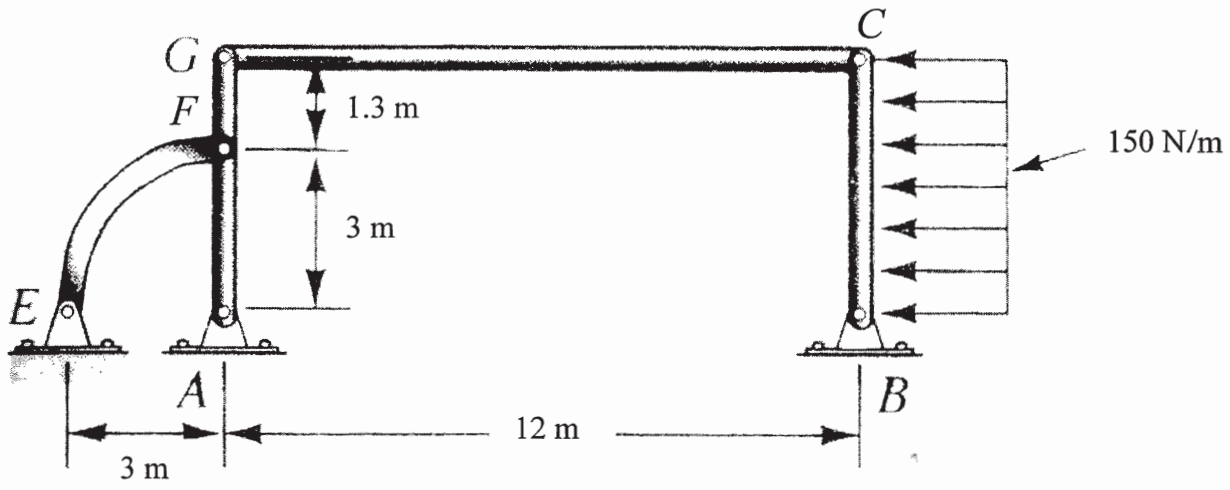
Euler's equation w.r.t. principal axes

$$M_{Ai} = \dot{H}_{Ai} = I_{ii}\dot{\omega}_i + \omega_j \omega_k (I_{kk} - I_{jj})$$

No summation over ii, jj, kk

Rough work

Q1. Find the supporting forces at A and B in the frame. Neglect weights of members.
Hint: EF is equivalent to a two-force member, along the chord EF.

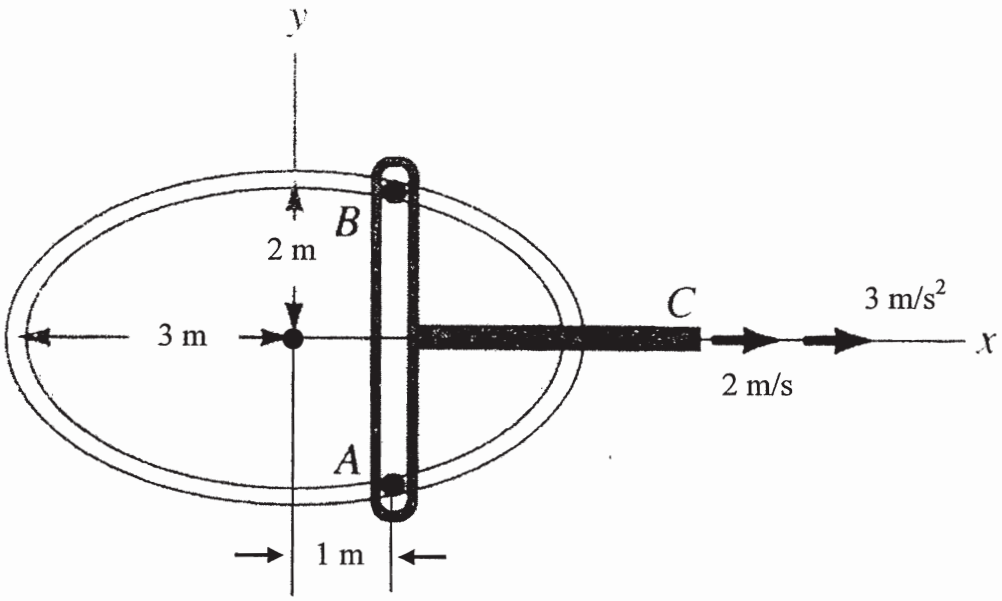


Q.No. 1 (Cont. 1)

Q.No. 1 (Cont. 2)

Q.No. 1 (Cont. 3)

Q2. Pins A and B must always remain in the vertical slot of yoke C, which moves to the right at a speed of 2 m/s. Furthermore, the pins cannot leave the elliptic slot. What are the velocity and acceleration vectors for pin B if the yoke C is accelerating at the rate of 3 m/s^2 at the instant of interest?

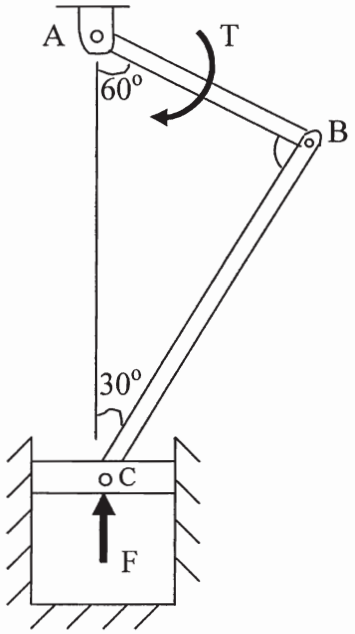


Q.No. 2 (Cont. 1)

Q.No. 2 (Cont. 2)

Q.No. 2 (Cont. 3)

Q3. Figure shows a piston and crank mechanism. A clockwise torque T is applied on AB. For a given torque T = 100 Nm as shown in figure, what is the force *F* developed by the piston *C*? Neglect the friction between the piston and the cylinder wall, and consider the pin joints to be ideal. AB = 0.5 m. Find the answer by equilibrium of forces, and by the method of virtual work.

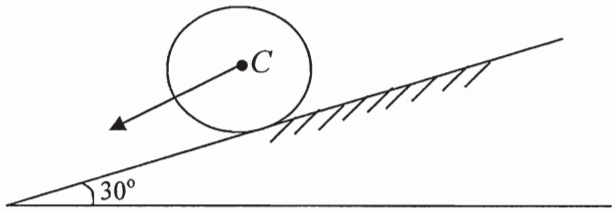


Q.No. 3 (Cont. 1)

Q.No. 3 (Cont. 2)

Q.No. 3 (Cont. 3)

Q4. A cylinder of mass 5 kg and radius 20 cm rolls without slipping down a 30° incline as shown. If the cylinder starts from rest, what is its speed after it has rolled 2 m along the incline? What is the kinetic energy of the cylinder at this stage? Neglect wind resistance. Also, if the wind resistance is not neglected, what is the maximum possible velocity that the cylinder would eventually attain taking the wind resistance to be $0.4\ V_c^2$, where V_c is the translational velocity of the centre of mass C of the cylinder? Assume wind resistance to have no effect on the rotation.

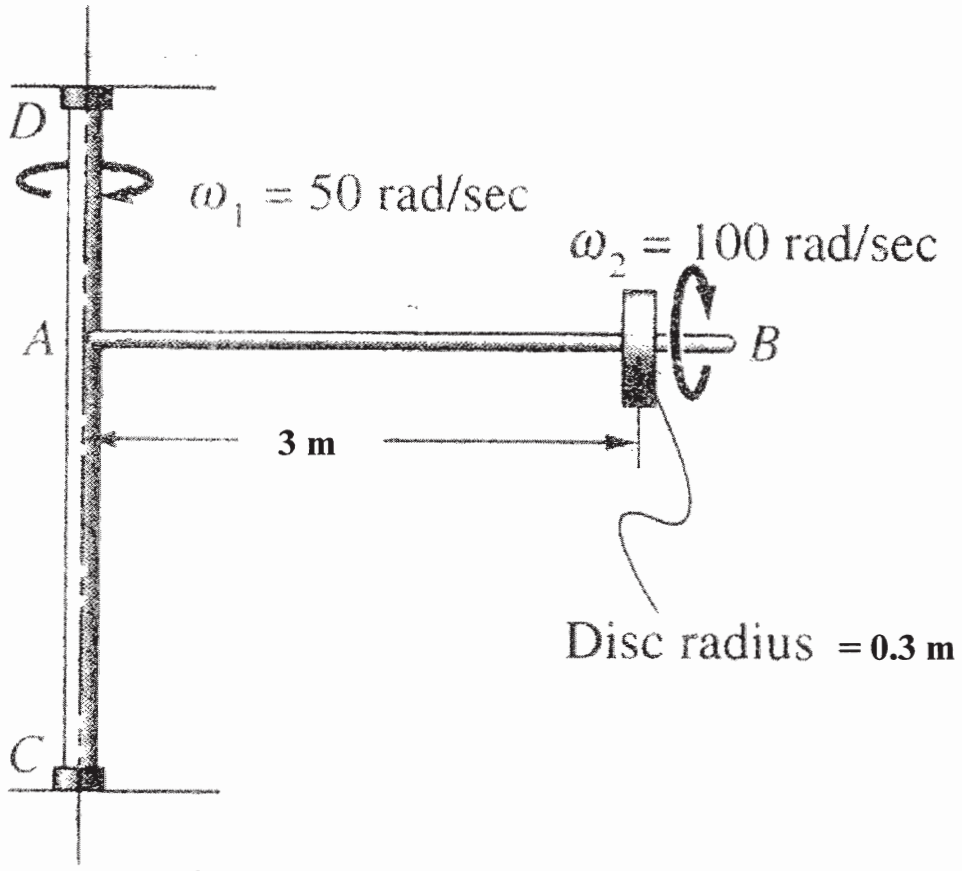


Q.No. 4 (Cont. 1)

Q.No. 4 (Cont. 2)

Q.No. 4 (Cont. 3)

Q5. A thin disc weighing 15 kg rotates on rod AB at a speed ω_2 of 100 rad/s in a clockwise direction looking from B to A. The radius of the disc is 0.3 m, and the disc is located 3 m from the centerline of the shaft CD, to which rod AB is fixed. Shaft CD rotates at ω_1 = 50 rad/s in a counterclockwise direction as we look from C to D. Find the tensile force, bending moment, and shear force on rod AB at the end A due to the disc.

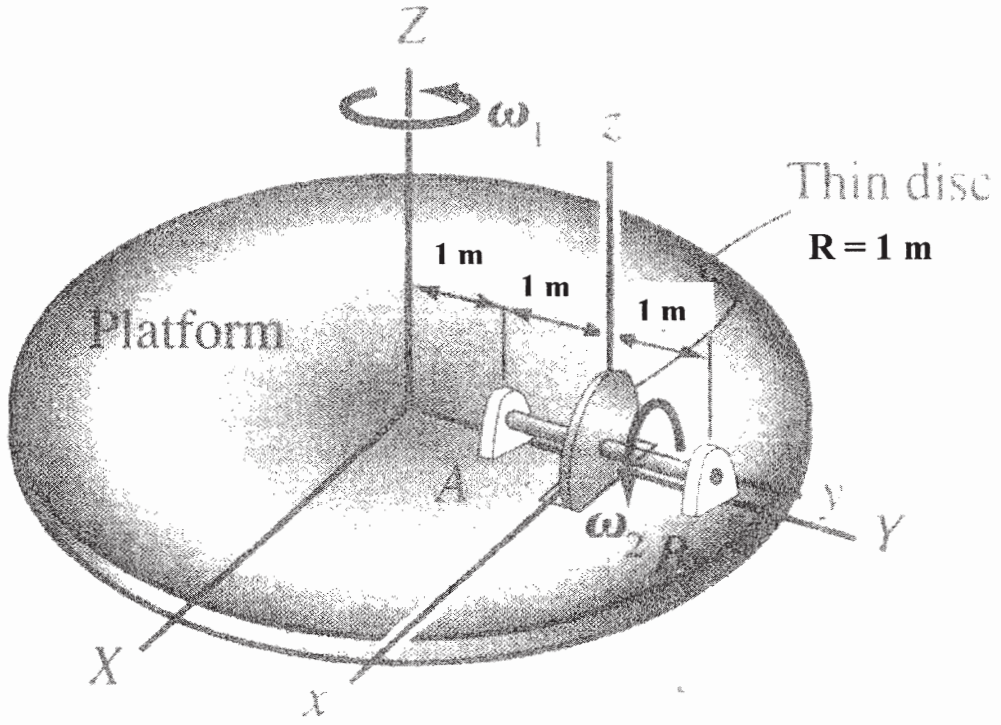


Q.No. 5 (Cont. 1)

Q.No. 5 (Cont. 2)

Q.No. 5 (Cont. 3)

Q6. In figure, a thin disc of radius R = 1 m and mass 150 kg rotates at an angular speed of ω_2 100 rad/s relative to a platform. The platform rotates with an angular speed ω_1 of 20 rad/s relative to the ground. Compute the torque on rod AB developed by the disc, and the equivalent point force developed on AB due to the motion of the centre of mass of the disc. Assume centre of mass of the disc to be in the same plane as the platform.



Q.No. 6 (Cont. 1)

Q.No. 6 (Cont. 2)

Q.No. 6 (Cont. 3)

Q7. A thin bent rod is sliding along a smooth horizontal surface. The center of mass has the velocity

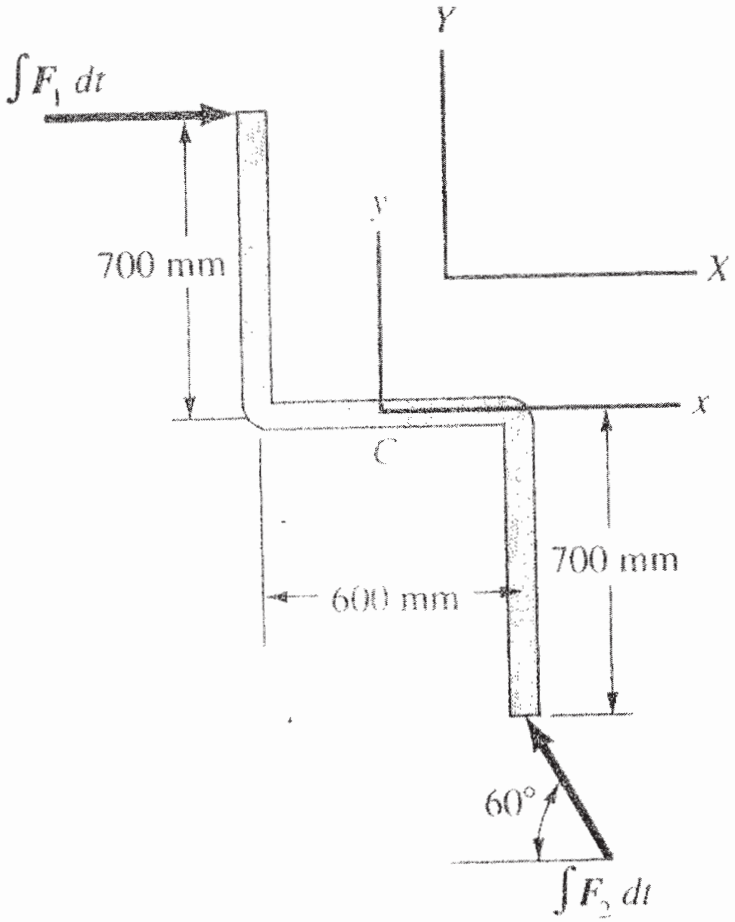
$V_c = 10i + 15j$ m/s

and the angular speed ω is 5 rad/s counterclockwise. At the configuration shown, the rod is given two simultaneous impacts as a result of a collision. These impacts have the following impulse values:

$$\int_1^2 F_1 dt = 5\,N-s$$

$$\int_1^2 F_2 dt = 3\,N-s$$

What is the angular speed of the rod and the linear velocity of the mass center, directly after the impact? The rod weighs 35 N/m.

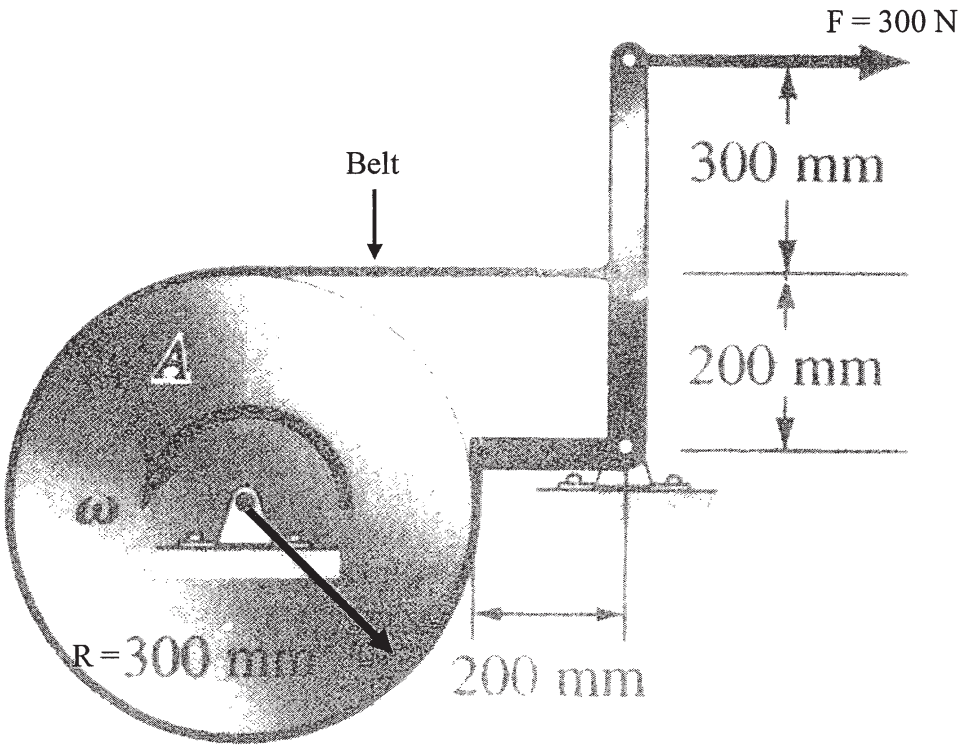


Q.No. 7 (Cont. 1)

Q.No. 7 (Cont. 2)

Q.No. 7 (Cont. 3)

Q8. A cylinder A is rotating at a speed ω of 1,750 rpm, when the light handbrake system is applied using a constant force F = 300 N. If the cylinder has a radius of gyration of 200 mm and a mass of 500 kg, how long a time does it take to halve the speed of the cylinder? The handbrake operates due to the tightening of the belt around the cylinder. Also $\mu_d = 0.3$.



Q.No. 8 (Cont. 1)

Q.No. 8 (Cont. 2)

Q.No. 8 (Cont. 3)