2·Pm   24/4/17
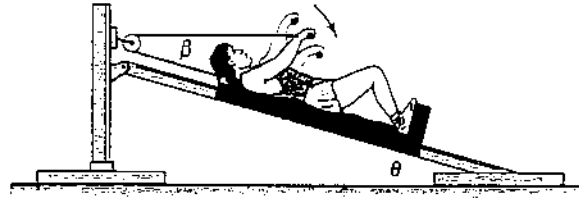
INDIAN INSTITUTE OF ENGINEERING SCIENCE AND TECHNOLOGY, SHIBPUR
B.TECH-M.TECH DUAL DEGREE 2nd SEMESTER (AE, CE, ME, Met, Min) FINAL EXAMINATION, 2017
MECHANICS (AM 1201)
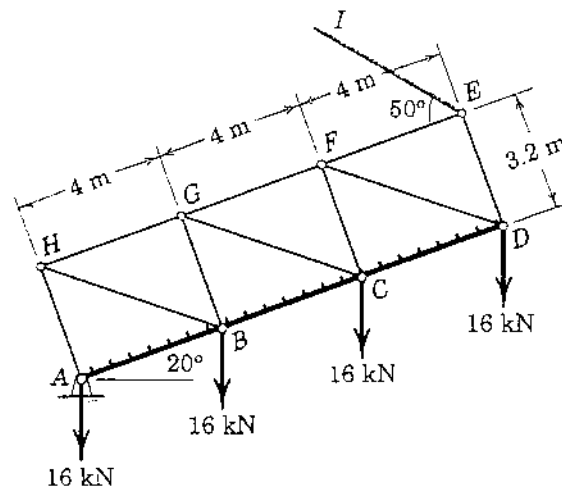
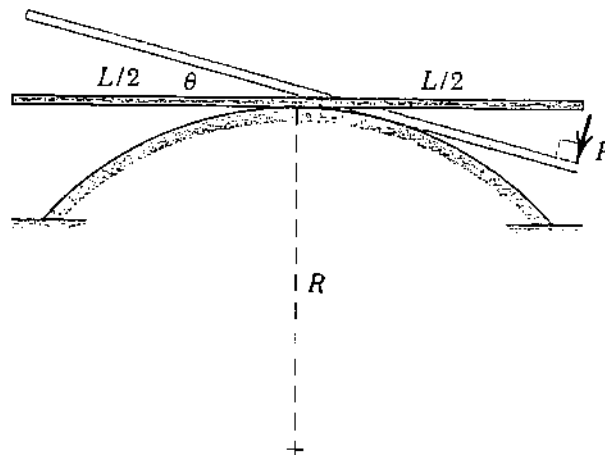FULL MARKS: 70   TIME: 3 Hrs

i) Answer any Seven questions
ii) Each question carries equal marks.
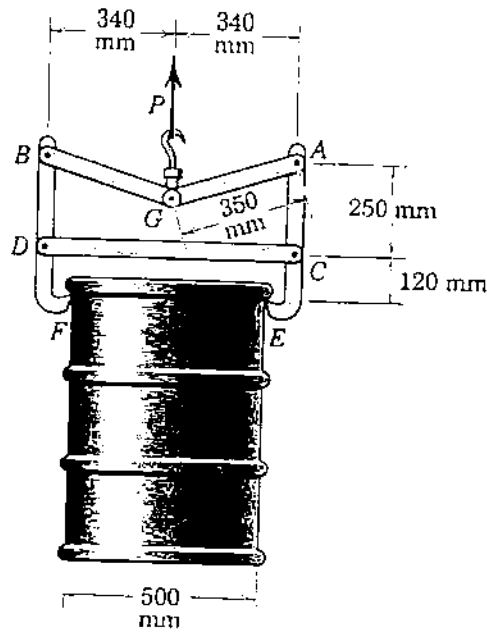*iii) Notations used carry their conventional senses.*

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1. The exercise machine, shown above, consists of a lightweight cart which is mounted on small rollers so that it is free to move along the inclined ramp. Two cables are attached to the cart – one for each hand. If the hands are together so that the cables are parallel and if each cable lies essentially in a vertical plane, determine the force P which each hand must exert on its cable in order to maintain an equilibrium position. The mass of the person is 70 kg, the ramp angle is 15^0 and the angle β is 18^0. In addition, calculate the force R which the ramp exerts on the cart.
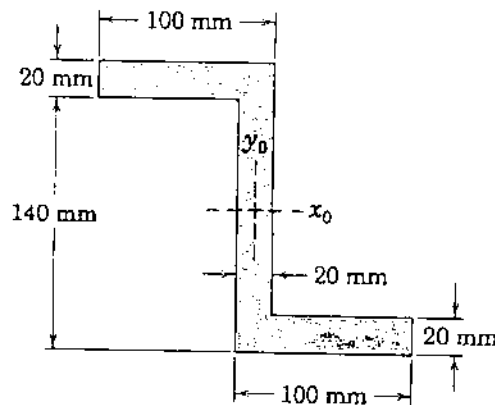

2. A drawbridge, shown above, is being raised by a cable EI. The four joint loadings shown result from the weight of the roadway. Determine the forces in members EF, DE, DF, CD, and FG.
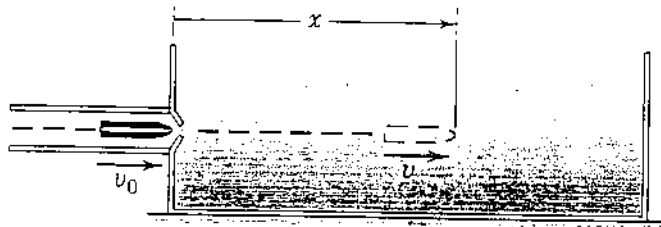

3. The uniform slender rod, shown above, of mass m and length L is initially at rest in a centered horizontal position on the fixed circular surface of radius $R = 0.6L$. If a force P normal to the bar is gradually applied to its end until the bar begins to slip at the angle $\theta = 20^0$, determine the coefficient of static friction μ_s.
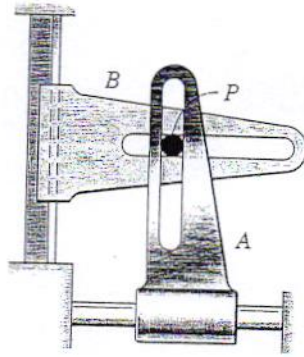
1

PTO

4. A lifting device for transporting 135-kg steel drums is shown above. Calculate the magnitude of the force exerted on the drum at E and F.
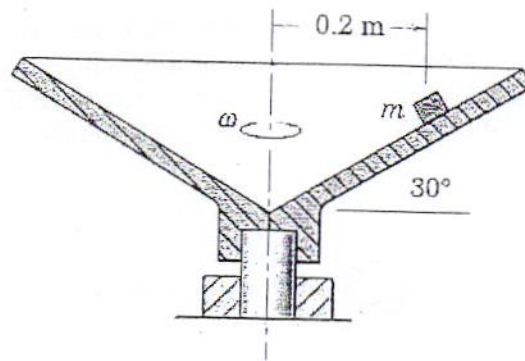

5. Determine the moments of inertia of the Z-section, shown above, about its centroidal x_0- and y_0-axes.
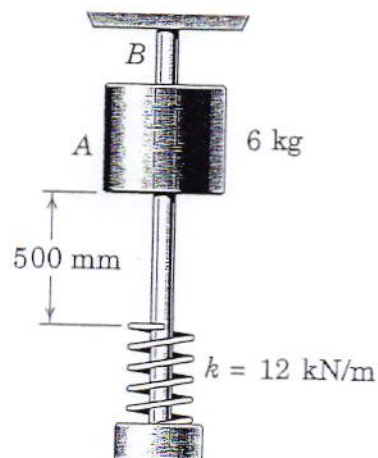

6. A test projectile is fired horizontally into a viscous liquid with a velocity v_0. The retarding force is proportional to the square of the velocity, so that the acceleration becomes $a = -kv^2$. Derive expressions for the distance D travelled in the liquid and the corresponding time t required to reduce the velocity to $v_0/2$. Neglect any vertical motion.
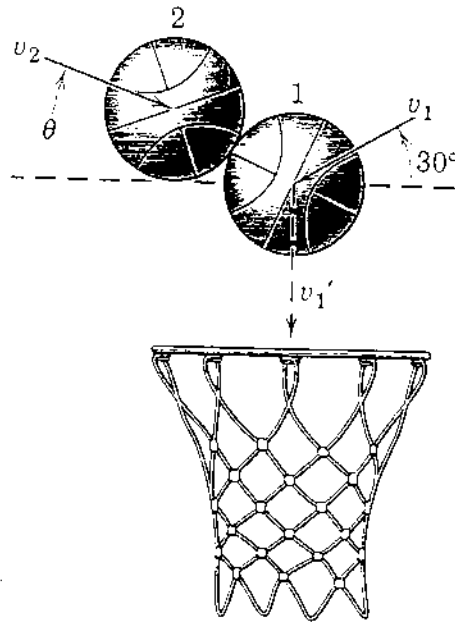
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7. The pin P is constrained to move in slotted guide that move at right angles to one another as shown above. At the instant represented, guide A has a velocity to the right of 0.2 m/s which is decreasing at the rate of 0.75 m/s each second. At the same time, B is moving down with a velocity of 0.15 m/s which is decreasing at the rate of 0.5 m/s each second. For this instant determine the radius of curvature ρ of the path followed by P.
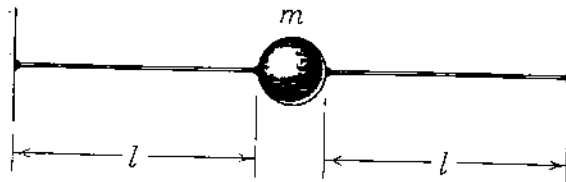

8. The small object is placed on the inner surface of the conical dish at the radius shown above. If the coefficient of the static friction between the object and the conical surface is 0.30, for what range of angular velocities ω about the vertical axis will the block remain on the dish without slipping? Assume that the speed changes are made slowly so that any angular acceleration may be neglected.

9. The 6 kg cylindrical collar is released from rest in the position shown above and drops onto the spring. Calculate the velocity v of the cylinder when the spring has been compressed 50 mm.
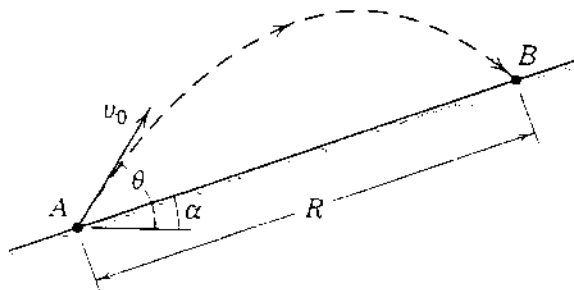
10. During a pregame warmup period, two basketballs collide above the hoop when in the positions shown above. Just before impact, ball 1 has a velocity v_1 which makes a 30° angle with the horizontal. If the velocity v_2 of ball 2 just before impact has the same magnitude as v_1, determine the two possible values of the angle θ, measured from the horizontal, which will cause ball 1 to go directly through the center of the basket. The coefficient of restitution is $e = 0.8$.

11. A small particle of mass m is attached to two highly tensioned wires as shown above. Determine the system natural frequency ω_n for small vertical oscillations if the tension T in both wires is assumed to be constant.

OR

A projectile is launched with speed v_0 from point A as shown above. Determine the launch angle θ that results in the maximum range R up the incline of angle α (where $0 \le \alpha \le 90°$). Evaluate your results for $\alpha = 0$, 30° and 45°.