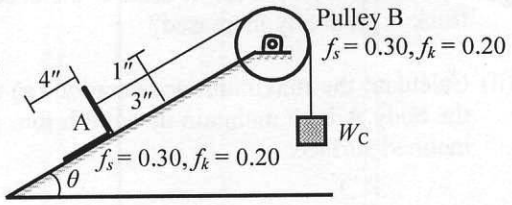
University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2012 (Set A)
Program: B. Sc. Engineering (Civil)

Course Title: Engineering Mechanics II Credit Hours: 3.0 Course Code: CE 103
Time: 3 hours Full Marks: 100 (= 10 × 10)

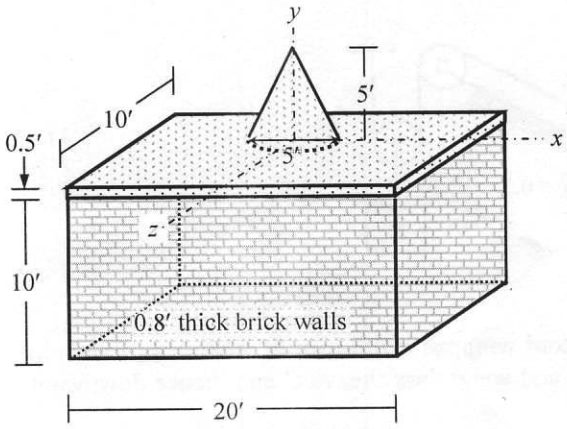
[Answer **any 10 (ten)** of the following 14 questions]

1. Figure below shows a (4″× 4″) L-beam A (W_A = 100 lb) being pulled along an inclined plane (θ = 30°) by a cable using weight W_C over pulley B.

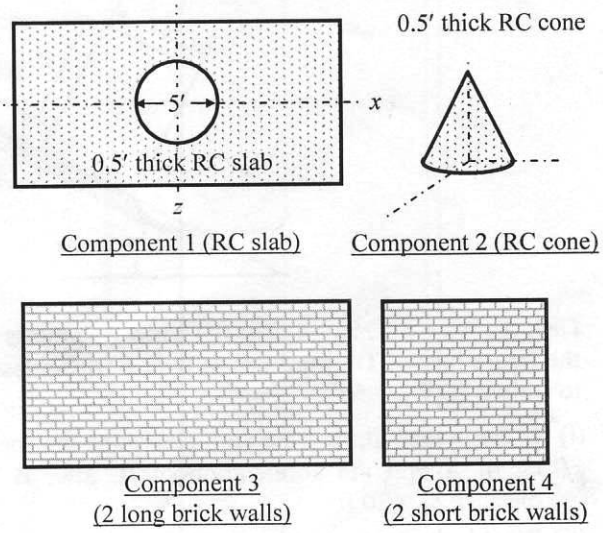
   Calculate the required weight W_C if the beam impends to (i) slide downward, (ii) slide upward, (iii) overturn [Given: f_s = 0.30, f_k = 0.20 for pulley and plane].



2. The figure below shows a (20′× 10′) room with 0.5′-thick RC slab and 0.8′-thick brick walls, as well as the four components it is made of. Calculate its mass moment of inertia about y-axis [Given: Unit weight of RC = 150 lb/ft^3, Unit weight of brick = 120 lb/ft^3].

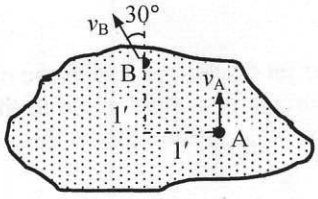


Isometric View of Room



3. The plate shown below is spinning about its centro. If velocity of A is v_A = 10 ft/sec, determine the

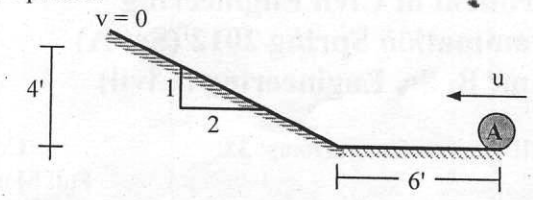
   (i) location of the centro,
   (ii) angular velocity of the plate,
   (iii) normal accelerations at A and B.



4. A particle travels along a curve $y = 2x - x^2$ with a constant horizontal velocity v_x = 100 ft/sec. Calculate its
   (i) velocity when x = 0,
   (ii) acceleration when it reaches y_{max}.

5. Calculate W_C for the system described in Question 1, if the L-beam slides
   (i) upward, (ii) downward
   with an acceleration of 10 ft/sec^2.

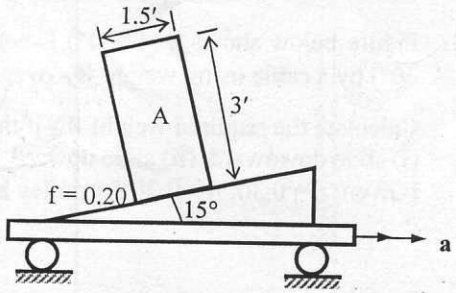
6. Calculate the initial speed (u) of block A if it comes to rest climbing 4' height of the inclined surface. Assume f= 1/3 for all planes.



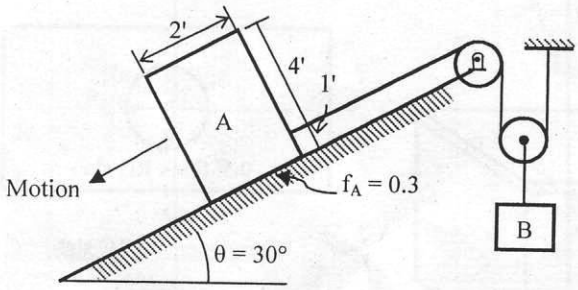
7. Homogeneous body A, weighing 300 lb, is loaded on a truck on an inclined surface as shown in the following figure.

(i) Will the body tip over or slide if the acceleration of the truck is gradually increased?

(ii) Calculate the maximum acceleration (**a**) of the truck, if the body A is to maintain its equilibrium position on the inclined surface.



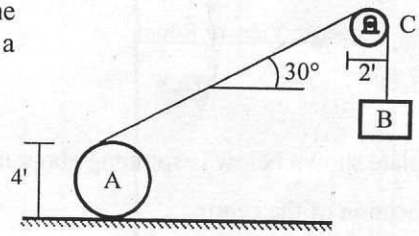
8. Figure below shows a homogeneous body A weighing 1000 lb. Assume the pulleys to be weightless and frictionless and determine the (i) weight of B when the body A is on the point of turning over, (ii) the weight of B when the body A is sliding down the plane at an acceleration of 1.5fps^2.



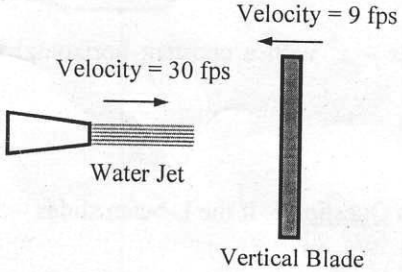
9. Disk A ($W_A = 80^{\#}$, $I_A = 4$ slug-ft^2) has a weightless cord wrapped about its mid section, as shown in the figure below. The cord passes over a frictionless and weightless sheave C and thence downward to weight B ($W_B = 50^{\#}$).

(i) If the system starts from rest, determine the speed of the cg of A and the acceleration of B. after B travels a distance $S_B = 20$ ft

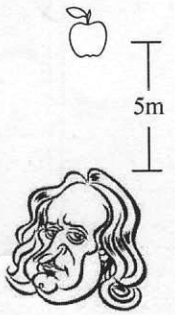
(ii) What is the tension in the cord?



10. A cylindrical water jet discharges 150 lb/sec moving with an absolute velocity of 30 fps and strikes a flat plate whose surface is at right angle to the jet as shown in the following figure. Determine the force exerted on the plate by the water if the plate moves at 9 fps in the opposite sense as the water.



11. Once Newton was thinking sitting below an apple tree, when suddenly an apple fell from 5m height, hit his head and bounced back upward.



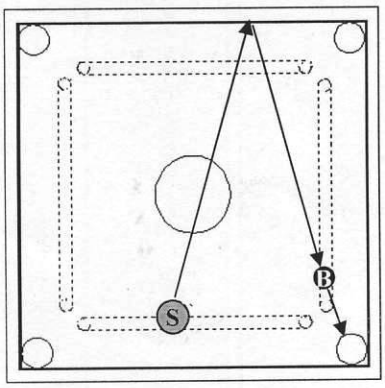
(i) Determine the velocity at which the apple hit Newton's head and the velocity at which it bounced back.

(ii) How far did the apple rise on rebound?

(iii) Calculate the loss of kinetic energy during the impact.

[Assume mass of the apple and Newton are 100 g and 70 kg respectively. Also assume the coefficient of restitution of Newton's head is 0.20].

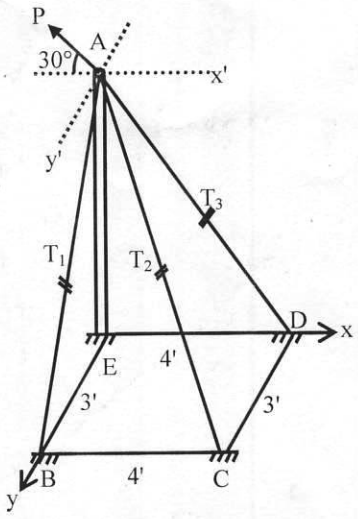
12. At the end of a board of carom only one black coin left. A player hit the striker in such a manner that it hits the black coin following the path shown in the following figure. The distance between the black coin and the nearest pocket is 0.5 ft.



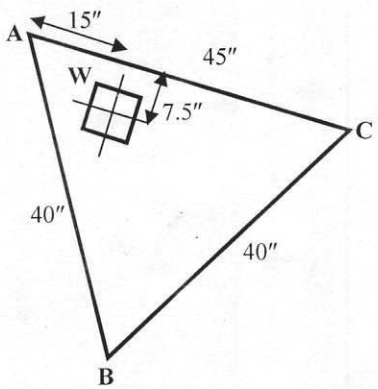
If the black coin travels the distance to pocket with a deceleration due to friction of 1 fps^2, determine the final velocities of the striker and the coin.

[Assume,
Coefficient of friction between striker and the board = 0
Coefficient of restitution between black coin and the striker = 0.2
Coefficient of restitution between striker and the board = 1
Mass of black coin = (2/3) x Mass of striker].

13. In the following figure AE = 10 ft and force P is in the plane x'-y'. The compressive force on AE is 1800 lb and T_1= 250 lb. Calculate T_2, T_3 & P.



14. As shown in the following figure, the weight W = 90 lb is placed on a weightless triangular table, which is supported at A, B and C. Calculate the support reactions.



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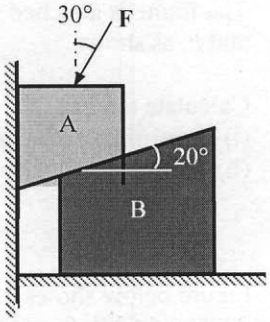
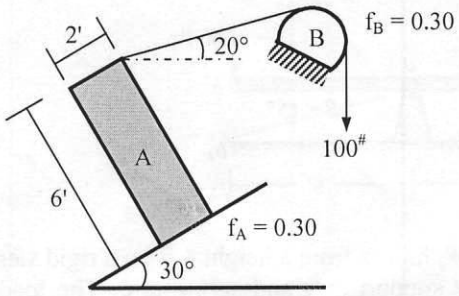
[Answer **any 10 (ten)** of the following 14 questions]

1. The weights of the blocks A and B are 60 lb and 150 lb respectively. Co-efficient of static friction between all the contacting surfaces is 0.10.

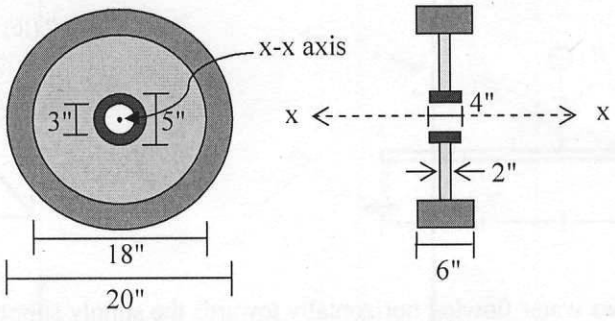
   What is the largest force **F** that can be applied without causing the blocks to slip?



2. In the figure shown below, determine the maximum weight of the block A for which it will turn over.



3. Determine the moment of inertia of the flywheel (shown in the figures below) about the x-x axis.



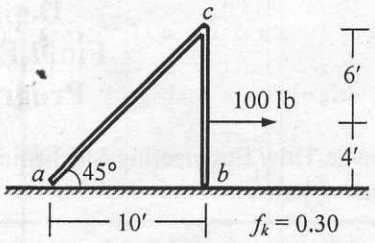
Front View | Side View

4. A rotating wheel follows the equation $\alpha = -4\theta^{1/2}$ rad/ sec^2 has an initial angular velocity of 50 rad/sec. After 7 revolutions, what are the tangential and normal acceleration of a point whose distance from wheel center is 18 in?

5. The mass of the block B in figure shown in Question no. 1 is 150 lb. Co-efficient of static friction between all the contacting surfaces is 0.1. If the block A will slide down the plane from rest at an acceleration of 0.2 fps, what will be the weight of the block A?

6. A 100 lb force is applied horizontally on the frame *abc* (weighing $W = 100$ lb) shown in the figure below, and moved over a floor with friction factor $f_k = 0.30$.

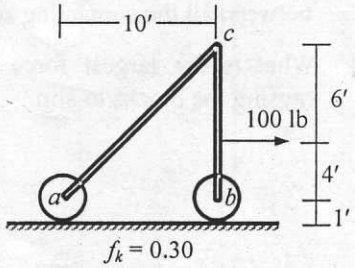
   Calculate the
   (i) acceleration of the frame
   (ii) reaction at *a* and *b*.



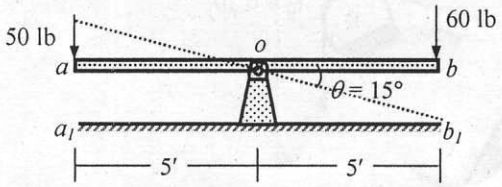
7. A 100 lb force is applied horizontally on the frame *abc* (weighing $W = 100$ lb) shown in the figure below, and moved 10-ft over a floor with friction factor $f_k = 0.30$.

   The frame is attached with two 2′-dia wheels (weighing 5 lb each) at *a* and *b*, as shown.

   Calculate the
   (i) centroidal velocity of the frame
   (ii) rotational velocity of the wheels.

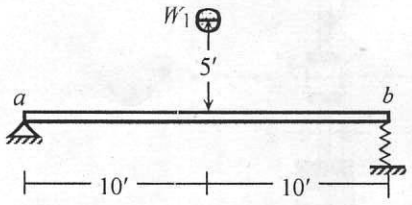


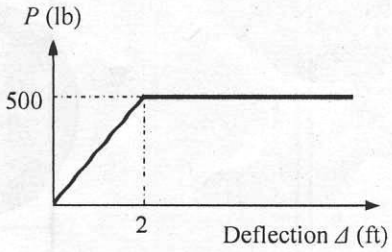
8. Figure below shows a 10-ft long slender rod *aob* (weighing 50 lb) being used as a see saw, applying 50 lb and 60 lb forces at *a* and *b* respectively. Calculate its rotational velocity
   (i) after traveling an angular distance $\theta = 15°$ from the initial position *aob*
   (ii) at the position *aob* after rebounding from b_1 with an initial angular velocity of 1 rad/sec.



9. Figure below shows weight W_1 falling from a height 5 ft on a rigid slender rod (weighing $W_2 = 10$ lb), which is supported on hinge support at *a* and spring at *b*. The load-deflection (P-Δ) curve of the spring is also shown.

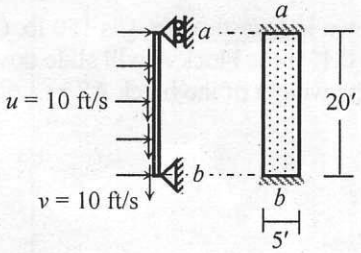
   Calculate the weight W_1 required to deflect the spring by an amount Δ = (i) 2 ft, (ii) 3 ft.



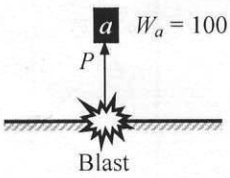


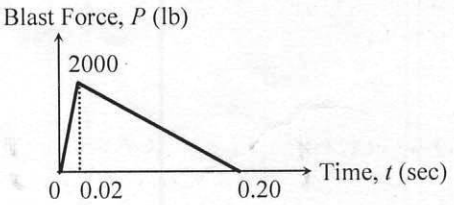
10. Figure below shows water flowing horizontally towards the simply supported wall *ab* with a velocity of $u = 10$ ft/s and moving over it vertically with the same velocity (i.e., $v = 10$ ft/s).

    Calculate the magnitude and direction of the resultant force on the beam and reactions at supports *a* and *b* [Given: Unit weight of water = 62.5 lb/ft^3].

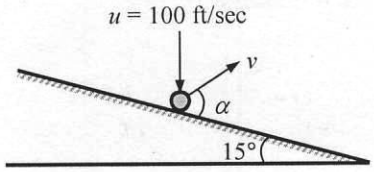


11. The object a is subjected to a vertical blast force P, whose variation with time is shown below. If it was initially at rest, calculate
    (i) when it will start moving (i.e., when P will overcome its weight)
    (ii) its velocity when $t = 0.02$ and 0.20 second
    (iii) the maximum height reached by a after the blast force stops acting (i.e., after 0.20 second).



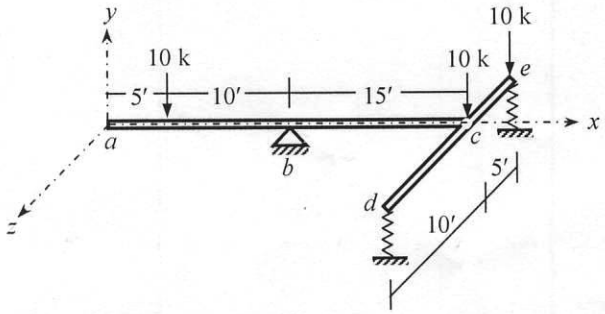


12. A cricket ball hits a 15° inclined surface vertically with a velocity of u = 100 ft/sec and rebounds with a velocity v.



    Calculate the
    (i) magnitude of rebound velocity (v) of the ball and angle (α) it makes with the inclined surface after impact
    (ii) loss of energy of the ball due to the impact.

13. The figure below shows a rigid horizontal grid *abcde* (assumed weightless) with a hinge support b and springs at d and e. Calculate the
    (i) reactions at the support and the springs,
    (ii) vertical deflections at d, e and c [Given: Spring stiffness $k_d = k_e$ = 100 k/ft].



14. In the 3D truss loaded as shown below, determine the forces in members
    (i) *ab*, *ac* and *ad*
    (ii) *de*, *df* and *dg*.