University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2012 (Set 2)
Program: B. Sc. Engineering (Civil)

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

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

1. Fig. 1 shows a rigid body *abc* with uniform bars *ab* and *bc* weighing 30 lb and 20 lb respectively.

   Calculate the force P (and corresponding value and location of normal force and friction force) required to
   (i) slide the body along *bc*, (ii) overturn the body

   [Given: $f_s = 0.40$].

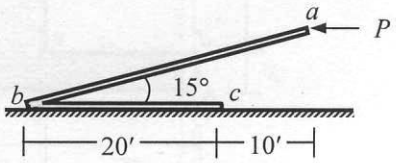


Fig. 1

2. Fig. 2 shows a rigid bar *AB* (weighing $W_{AB} = 10$ lb) supported by cables *Aa* and *Bb*, which are both wrapped around pulley *C*.

   Calculate the required weight *W* if it is at impending motion
   (i) upward, (ii) downward

   [Given: $f_s = 0.40$ for the pulley].

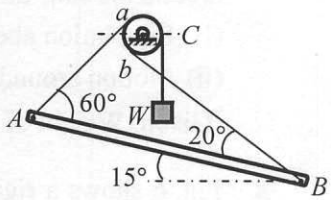


Fig. 2

3. Calculate the
   (i) Mass moment of inertia (I_z) and
   (ii) Radius of gyration (k_z)

   of the concrete pile group-pile cap composite shown in Fig. 3 about the *z*-axis

   [Given: Unit weight of concrete = 150 lb/ft^3].

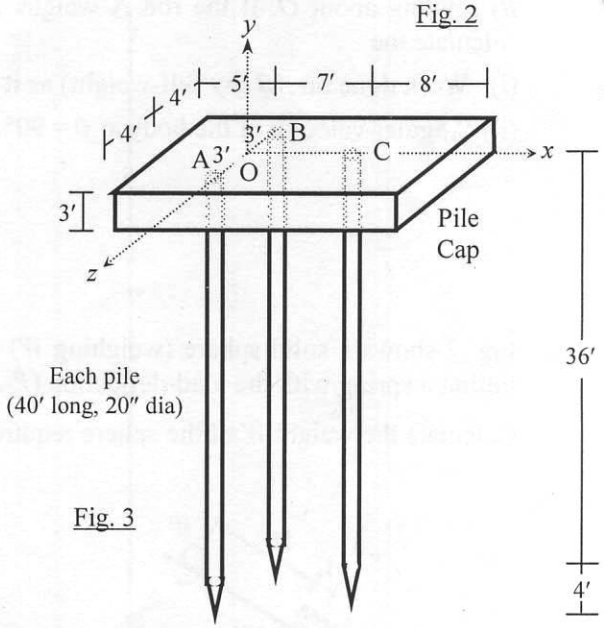


Fig. 3

4. Fig. 4 shows a body starting from rest at A, dropping freely (under gravity) to point B, and then moving along the curve $x^2 + y^2 = 100$ at constant velocity v_B (the velocity gained at B) up to point D.

   Calculate its
   (i) Horizontal and vertical velocity at C
   (ii) Horizontal and vertical acceleration at C.

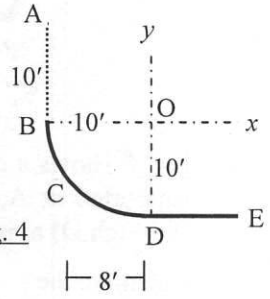


Fig. 4

5. The body (weighing 20 lbs) traveling as shown in Fig. 4 (and as described in Question 4) reaches D and then travels along a rough surface DE to stop at E. Calculate the
   (i) Centripetal force, normal force and friction force on the body at D,
   (ii) Distance DE and time required to travel between AB and DE [Given: $f_s = 0.40$, $f_k = 0.30$].

6. Fig. 5 shows a rigid body (*abcgihdea*) being subjected to horizontal for force $P = 500$ lb/ft, resisted by normal force N and friction force F between the brick surface *hi* and the soil underneath.

   Calculate the acceleration of the rigid body and corresponding value and location of N and F [Given: $f_s = 0.40, f_k = 0.30$].

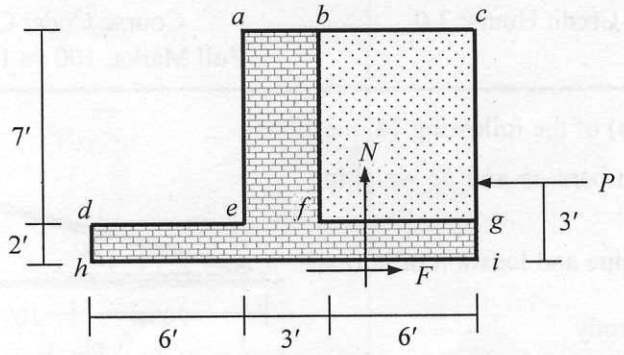


Fig. 5

7. Earth takes 24 hours to complete a full revolution around its own axis, and also travels at 18.6 mile/sec around the sun. Calculate its kinetic energy due to

   (i) Revolution about own axis,

   (ii) Motion around the sun

   [Given: Weight of the earth = 13×10^{24} lb, Diameter of earth = 8000 mile]

8. Fig. 6 shows a rigid body *AB* (composed of uniform slender rod *A* and sphere *B*) rotating about *O*. If the rod A weighs 20 lb and sphere B weighs 100 lb, calculate the

   (i) Work done on *AB* (by self-weight) as it moves from $\theta = 15°$ to $\theta = 90°$

   (ii) Angular velocity of the body at $\theta = 90°$ if it starts from rest at $\theta = 15°$.

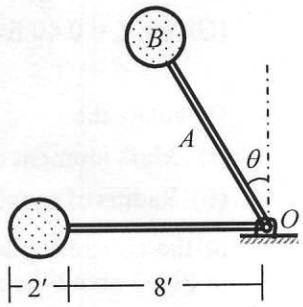


Fig. 6

9. Fig. 7 shows a solid sphere (weighing *W*) rolling down 15 ft along a 30° inclined smooth surface and hitting a spring with the load-deflection (*P*-*Δ*) curve as shown.

   Calculate the weight *W* of the sphere required to deflect the spring by an amount *Δ* = (i) 3 ft, (ii) 4 ft.

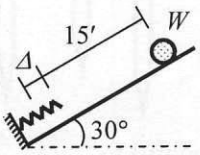
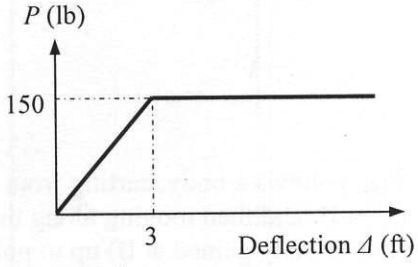


Fig. 7



10. Fig. 8 shows a curved pipeline ABCD (with cross-sectional area $a_p = 20$ in^2) supported at A, D and subjected to water flowing in (through A) and out (through D) at equal velocity $u = v = 10$ ft/sec.

    Calculate the

    (i) Magnitude and direction of the resultant force on the pipeline

    (ii) Reactions at supports A and D.

    [Given: Unit weight of water = 62.5 lb/ft^3]

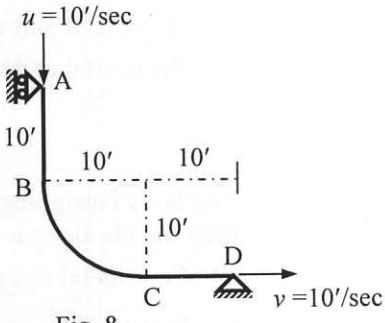


Fig. 8

11. An object a (weighing $W_a = 150$ lb) is subjected to a horizontal force $P = 90\ Sin(t)$ due to ground motion, whose variation with time is shown in Fig. 9.

If the object was initially at rest on a surface with $f_s = 0.30$ and $f_k = 0.20$, calculate

(i) when the object will start moving

(ii) the maximum velocity achieved by the object

(ii) when the object will stop again.

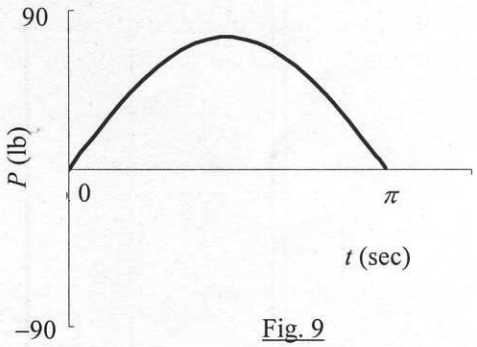


Fig. 9

12. Fig. 10 shows a cricket ball (weighing $W_A = 0.30$ lb) hitting a stump (weighing $W_B = 1.5$ lb, and initially at rest) with a velocity of $u_A = 140$ ft/sec at an angle 15° with the horizontal.

If the coefficient of restitution for the impact is $e = 0.80$, calculate the

(i) Velocity and direction of the ball and the stump after impact

(ii) Loss of energy in the impact.

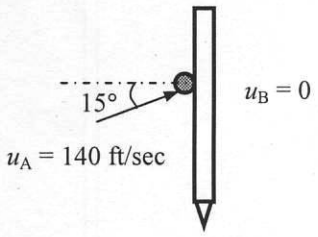
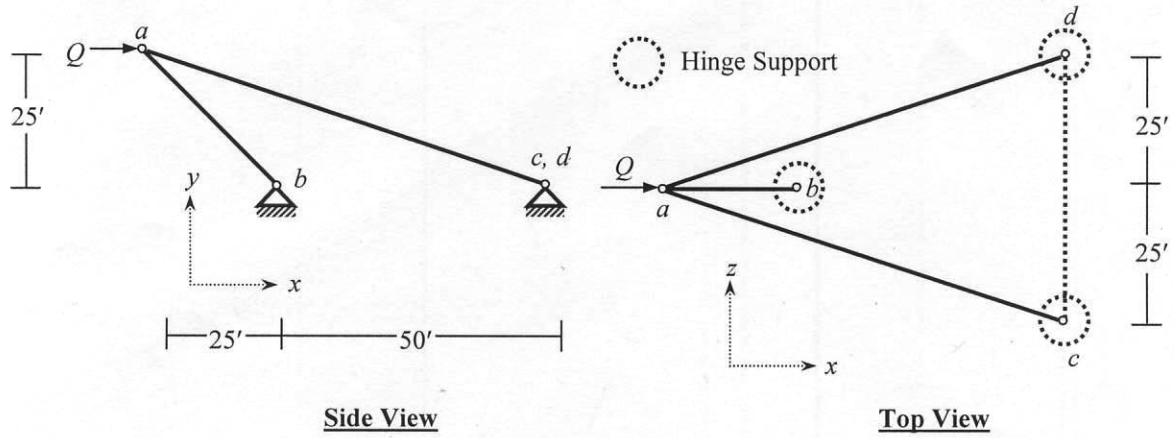


Fig. 10

13. For the space truss loaded as shown in Fig. 11

(i) Determine all member forces in terms of the applied force Q

(ii) Calculate the allowable value of Q if the allowable force in member ab and ac is 50 kip and 25 kip respectively.



Side View **Top View**

Fig. 11

14. If the pile-cap (shown if Fig. 3) weighs $W = 75$ kips and a force $P = 500$ kip acts on it vertically downward at O (i.e., in the negative y-direction), calculate the reactions in pile A, B and C.

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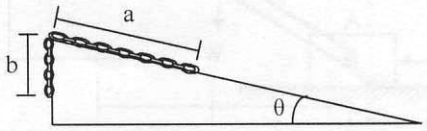
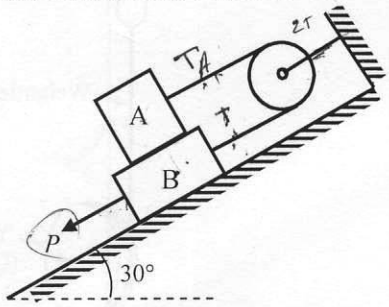
[Answer **any 10 (ten)** of the following **14 (fourteen)** questions]

1. If the coefficient of static friction between the chain and the inclined plane is $\mu_s = \tan\theta$, determine the overhang length b so that the chain is on the verge of slipping up the plane. The chain weighs w per unit length.

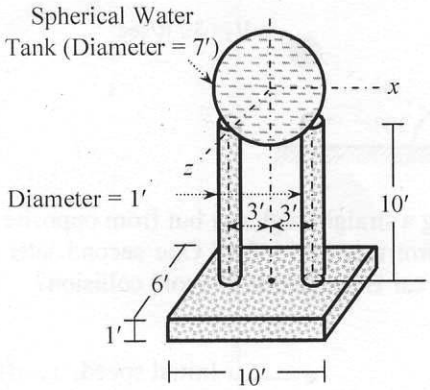


2. Block A and block B rests on each other, connected by a cord which passes over a frictionless pulley. Determine
   a) The force P needed to resist the down ward motion of block A.
   b) The tension in the cord connected to A and B.



$W_A = 75^{\#}$
$W_B = 50^{\#}$
$f_{(\text{Block A and B})} = 0.15$
$f_{(\text{Block B and inclined surface})} = 0.15$

3. For the structure shown in the figure below, calculate the mass moment of inertia (I_y) about the y-axis [Neglect the self-weight of the spherical water tank and assume the tank to be filled with water].



Water (Unit Weight = 62.5 lb/ft^3)

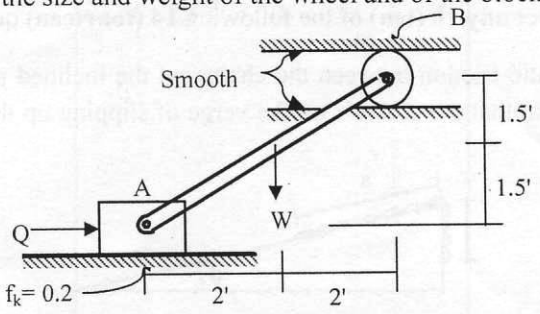
Reinforced Concrete (Unit Weight = 150 lb/ft^3)

4. If coefficient of kinetic friction for all contact surfaces shown in Question no. 2 is 0.10. Determine the acceleration of block B if $P = 200$ lb.

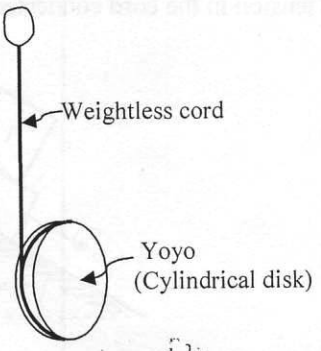
5. A person jumps (with initial velocity = 0) from the top of a 1000 ft tall building and falls freely under gravity for 2 seconds before his parachute opens, and he falls with acceleration $a = (g/v_0^2)(v_0^2 - v^2)$, where $g = 32.2$ ft/sec^2, $v_0 = 150$ ft/sec and v is the velocity of the person. Calculate the velocity when the person reaches ground.

6. A wheel which is rotating at 300 rpm is slowing down at the rate of 2 rad/ sec^2.
   a) What time will elapse before the wheel stops?
   b) At what rate (in rpm) is the wheel revolving after 10 sec?
   c) Through how many revolutions had it turned during the first 10 sec?
   d) What is the total displacement?
   e) Compute the number of revolutions from the time 10 sec until the wheel stops.

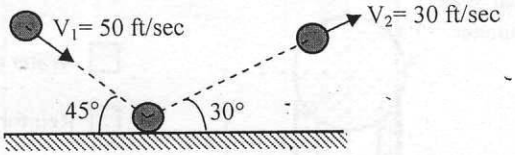
7. If the weight of the bar AB is W= 100 lb and Q= 500 lb find acceleration of the bar, ā and the reaction at B. Neglect the size and weight of the wheel and of the block.



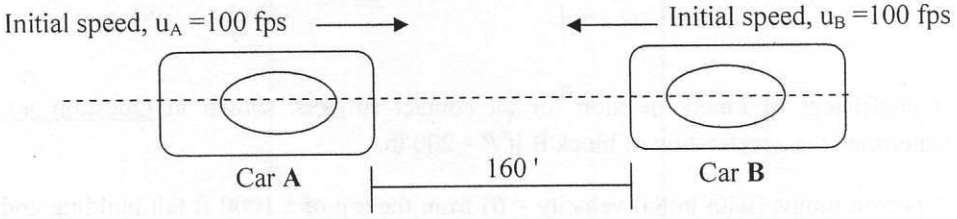
8. A boy is playing with a yoyo (which is a solid homogeneous cylindrical disk with a weightless cord wrapped about its mid section). One end of the cord is looped and the boy has his finger in it. If the yoyo is released at 0.6 ft/sec speed and moves vertically downward, what is the speed of its c.g. after a displacement of 1.5 ft?



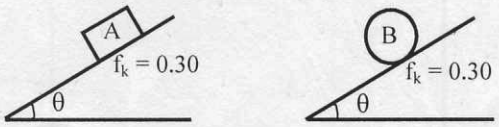
9. The 0.5 kg ball strikes the rough ground and rebounds with the velocities shown. Determine the magnitude of the impulse the ground exerts on the ball. Assume that the ball does not slip when it strikes the ground, and neglect the size of the ball and the impulse produced by the weight of the ball.



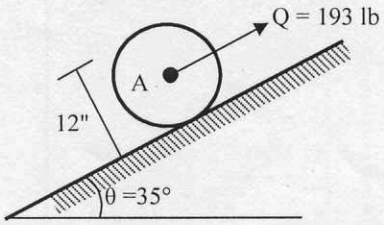
10. Two cars A and B are travelling in line along a straight highway but from opposite direction. Car A applies brakes and decelerates at a uniform rate of 15 fps^2. One second later car B applies brakes. At what minimum uniform rate must car B decelerate to avoid collision?



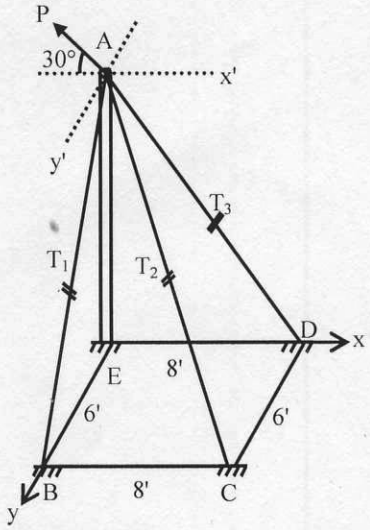
11. The figure below shows a box A and cylinder B moving down an inclined plane with $f_k = 0.30$. If both of them start from rest and move at the same speed, determine the angle θ.



12. Body A is a 161 lb cylinder that is being rolled up an inclined surface by a constant force Q = 193 lb.(i) What is the speed of its c.g. after a displacement of 15 ft. from rest? (ii) What is its angular acceleration?



13. In the following figure AE = 40 ft and force P is in the plane x'-y'. The compressive force on AE is 20 kips and T_1= 5 kips. Calculate T_2, T_3 & P.



14. As shown in the following figure, the weight W = 90 lb is placed on a weightless irregular shaped table which has supports at A, B and C. Find the reactions at supports A, B and C.