NAME:_____ Lab section/Lab time:_____

MECH 2110 Final Exam

Statics

1. The coordinates of two points A and B are:
   $A(x_A = 3,\ y_A = 4,\ z_A = 5)$ and $B(x_B = 2,\ y_B = 6,\ z_B = 9)$.
   1.1 Then $\overrightarrow{OA} \cdot \overrightarrow{OB}$ is: A) 75; B) 55; C) -75; D) 50.
   1.2 The angle between $\overrightarrow{OA}$ and $\overrightarrow{OB}$ in radians is: A) 0.132; B) 0.268; C) 0.391; D) 0.445.

2. Two vectors $\mathbf{A}$ and $\mathbf{B}$ are given: $\mathbf{A} = \mathbf{\imath} + 2\,\mathbf{\jmath} + 3\,\mathbf{k}$ and $\mathbf{B} = \mathbf{\imath} + \mathbf{\jmath} + \mathbf{k}$. Which is of the following vectors is perpendicular to both $\mathbf{A}$ and $\mathbf{B}$
   A) $-\mathbf{\imath} - 4\,\mathbf{\jmath} + \mathbf{k}$; B) $\mathbf{\imath} + 4\,\mathbf{\jmath} + 5\,\mathbf{k}$; C) $-\mathbf{\imath} + 2\,\mathbf{\jmath} - \mathbf{k}$; D) $\mathbf{\imath} - 2\,\mathbf{\jmath} + \mathbf{k}$.

3. Two identical circles with the radius r=1 m and a rectangle with the sides $4\,r$ and $0.5\,r$ are arranged as shown in Fig. 3. The x and y coordinates (in m) of the centroid of the composite area are
   A) (2, -0.5); B) (2, 0.8); C) (1/2, 0.7); D) (2, -0.7).

4. The planar region shown in Fig. 4 is formed by the area enclosed by the parabola $y = a\,x^2$ and the line $y = a$. If a=1 m, the first moment of area of this region about x-axis is
   A) 0.8 m^4; B) 0.08 m^3; C) 0.08 m^4; D) 0.8 m^3.

5. Two rectangles $ABCF$ and $FDEO$ are arranged as shown in Fig. 5. The following dimensions are given: $AB = 6$ m, $BC = 2$ m, $CD = 4$ m, $DE = 2$ m, and $OE = 10$ m.
   5.1 The product of inertia, I_{xy}, for the rectangle $FDEO$ is:
   A) 112 m^4; B) 108 m^4; C) 26.666 m^4; D) 100 m^4.
   5.2 The second moment of inertia, I_{xx}, for the rectangle $ABCF$ about x-axis is:
   A) 100 m^4; B) 108 m^4; C) 256 m^4; D) 112 m^4.

6. The forces F_1 of magnitude 300 lb and F_2 of magnitude $100\sqrt{2}$ lb act along the diagonals of the parallelepiped shown in Fig. 6. The dimensions of the parallelepiped are $a = 4'$, $b = c = 8'$.
   6.1 The vector force $\mathbf{F}_1$ is given by (in lb):
   A) 173.2($\mathbf{\imath}$+$\mathbf{\jmath}$+$\mathbf{k}$); B) 173.2($\mathbf{\imath}$-$\mathbf{\jmath}$-$\mathbf{k}$); C) 100($\mathbf{\imath}$-2$\mathbf{\jmath}$-2$\mathbf{k}$); D) 150($\mathbf{\imath}$-2$\mathbf{\jmath}$-2$\mathbf{k}$).
   6.2 The moment of the force $\mathbf{F}_2$ about O is (in lb·ft):
   A) 100(-$\mathbf{\jmath}$-$\mathbf{k}$); B) 400($\mathbf{\imath}$-$\mathbf{\jmath}$-$\mathbf{k}$); C) 400($\mathbf{\jmath}$+$\mathbf{k}$); D) 400($\mathbf{\jmath}$-$\mathbf{k}$).

7. A planar truss with $AB = BC = CE = l = 1$ ft and the angle $\angle BCE = 90°$ is shown in the Fig. 7. The vertical forces at A and B are $F_1 = F_2$=100 lb.
   7.1 The magnitude of the reaction force at the pin joint C is (in lb):
   A) $100\sqrt{13}$; B) $400\sqrt{13}$; C) $30\sqrt{13}$; D) 260.555.
   7.2 The magnitude of the force (in lb) in the member AD is: A) 100; B) 200; C) 250; D) 300.

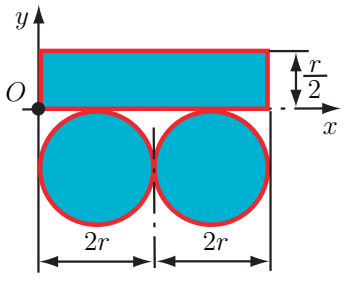

Figure 3: Problem 3

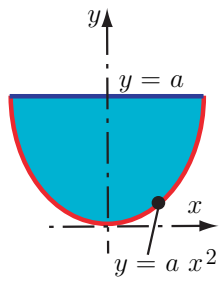

Figure 4: Problem 4

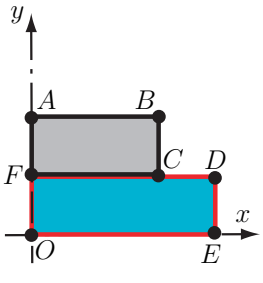

Figure 5: Problem 5

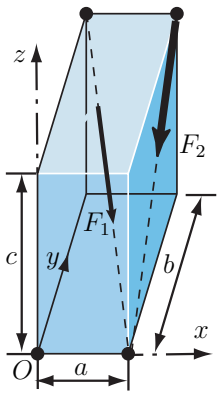

Figure 6: Problem 6

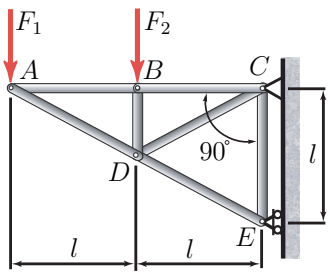

Figure 7: Problem 7

8. The acceleration of a particle as it moves along a straight line is given by $a = (2t - 1)$ m/s^2, where t is in seconds. The initial displacement and velocity are $s_0 = 1$ m and $v_0 = 2$ m/s when $t = 0$. The velocity of the particle at $t = 6$ s is: A) 20 m/s; B) 17.56 m/s; C) 32 m/s; D) 52.6 m/s.

9. The plane shown in the Fig. 9 is flying along a curvilinear path. The plane has the speed $v = 400$ ft/s and the acceleration $a = 70$ ft/s^2 acting in the direction shown in Fig. 9. The angle between the velocity and the the acceleration is $\theta = 60°$.
   9.1 The rate of increase in the plane speed (the tangential acceleration a_t) is (ft/sec^2):
   A) 70; B) 60.6 ; C) 35 ; D) 55 .
   9.2 The radius of curvature, ρ, of the path, is (ft): A) 400 ; B) 1315; C) 4567 ; D) 2639.

10. The slotted link shown in Fig. 10, is pinned at O, and has a constant angular velocity $\omega = \dot{\theta} = 3$ rad/s. The link drives the peg P along a spiral guide of equation $r = 0.4\ \theta$ (m), where θ is in radians. For the instant when $\theta = \pi/3$ rad
    10.1 the radial component of the velocity of the peg is
    A) $v_r = 1.2$ m/s; B) $v_r = 2.2$ m/s; C) $v_r = 0.42$ m/s; D) $v_r = 3$ m/s.
    10.2 the transverse component of the velocity of the peg is
    A) $v_\theta = 5.26$ m/s; B) $v_\theta = 7.32$ m/s; C) $v_\theta = 3$ rad/s; D) $v_\theta = 1.26$ m/s.

11. Plane A is flying along a straight line path and has the speed $v_A = 700$ km/h and the acceleration $a_A = 50$ km/h^2 acting in the directions shown in the Fig. 11. Plane B is flying along a circular path having a radius of curvature of $\rho = 400$ km. The speed of the plane B is $v_B = 600$ km/h and the tangential acceleration is $a_B^t = 100$ km/h^2 as shown in the Fig. 11. The distance between the planes is $d = 4$ km.
    11.1 What is the velocity of plane B as measured by the pilot of A
    A) -100 **j** km/h; B) 700 **j** km/h; C) 600 **j** km/h; D) 100 **i** km/h.
    11.2 What is the acceleration of plane B as measured by the pilot of A
    A) 345.365 **i** + 204.297 **j** km/h^2; B) 900 **i** km/h^2; C) -150 **j** km/h^2; D) 900 **i** $-$ 150 **j** km/h^2.

12. Two spheres 1 and 2 of same size but of different material with the masses $m_1 = 50$ kg and $m_2 = 100$ kg, respectively, are dropped from a tall building precisely at a same time. Assume air drag is negligible and there is no wind. Which sphere will hit the ground first?
    A) sphere 1 ($m_1 = 50$ kg); B) sphere 2 ($m_2 = 100$ kg); C) both spheres; D) insufficient data.

13. During a brake test, a car is stopped from an initial speed of $v_i = 100$ km/h in a distance of $s = 50$ m. Assume a constant deceleration for the car with the mass $m = 1500$ kg. All the four wheels contribute equally to the braking force. The braking force F at each wheel of the car is
    A) $F = 1500$ N; B) $F = 2894$ N; C) $F = 5000$ N; D) $F = -1000$ N.

14. A car has a speed $v_A = 5$ m/s at point A as shown in the Fig. 14. Neglecting friction, what is the speed of the car at point B, v_B, after it has risen $h = 0.8$ m with respect to a point A,
    A) 10.59 m/s; B) 4.9 m/s; C) 3.05 m/s; D) 13.89 m/s.

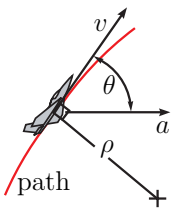

Figure 9:
Problem 9

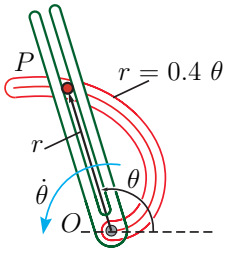

Figure 10:
Problem 10

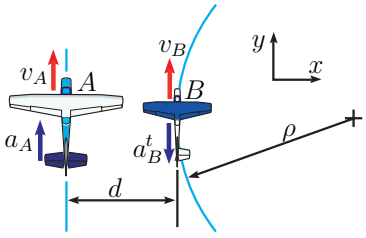

Figure 11:
Problem 11

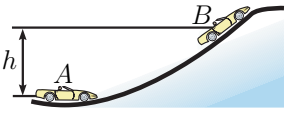

Figure 14:
Problem 14