Instructions: There are 10 questions on this exam of which you must do 8. Each problem is scored out of 8 points for a total of 64 points. You may not use any outside materials (eg. notes or calculators). You have 3 hours to complete this exam. Remember to fully justify your answers. Mark clearly in your blue book which problems are to be graded.

Problem 1. A particle moves through space with position \( r(t) = \langle t, t^2, \frac{4}{3}t^{3/2} \rangle \).
   (1) Find the symmetric and parametric equations for the tangent line at \((1, 1, \frac{4}{3})\).
   (2) Find the curvature at \((1, 1, \frac{4}{3})\).

Problem 2. For the two planes \( S_1 : 4x + y - z = 4 \) and \( S_2 : 2x + 2y + z = 3 \).
   (1) Find the line of intersection of \( S_1 \) and \( S_2 \).
   (2) Find the angle between \( S_1 \) and \( S_2 \).

Problem 3. Determine the following two limits (if they exist).
   (1) \( \lim_{(x,y) \to (0,0)} \frac{5x^2y}{x^2+y^2} \).
   (2) \( \lim_{(x,y) \to (0,0)} \frac{5x^2y}{x^2+y^2} \).

Problem 4. The plane \( 8x - 8y - 2z = C \) is tangent to the surface \( z = x^2 + 2y^2 \) at a certain point \((x_0, y_0, z_0)\). Find \((x_0, y_0, z_0)\) and the constant \( C \).

Problem 5. Classify the critical points for \( f(x, y) = x^4 + y^4 - 4xy + 1 \).

Problem 6. Find the point(s) on the surface \( 2x^2 + 3y^2 + 6z^2 = 36 \) the sum of whose coordinates is maximal.

Problem 7. Find the moment of inertia about the \( x \)-axis for the triangle bounded by \( 3x + 4y = 24 \), \( x = 0 \), and \( y = 0 \) and having constant density 1.

Problem 8. Find the volume bounded by \( y = x^2 + 2z^2 \) and \( y = 4 - x^2 \).

Problem 9. Evaluate
\[
\int_{-1}^{1} \int_{-\sqrt{2-x^2}}^{\sqrt{2-x^2}} \int_{x^2+y^2}^{2-x^2-y^2} (x^2 + y^2)^{3/2} dz dy dx.
\]

Problem 10. A closed path \( C \) is traversed counter-clockwise beginning at \((-1, -1)\) and moving to \((2, 2)\) along the curve \( y = x^2 - 2 \) then returning to the point \((-1, -1)\) along the curve \( y = x \). Find
\[
\int_C -xy dx + \frac{x^2}{2} dy
\]
in two ways.
   (1) Parameterizing the curves and computing the line integral directly.
   (2) Using Green’s Theorem.