Duration: 50 minutes
Instructions: Answer all questions, without the use of notes, books or calculators. Partial credit will be awarded for correct work, unless otherwise specified. The total number of points is 50.

1. (14 pts: 3, 3, 3, 5) $z = 5 - 3x + 4y$ is the tangent plane to the graph of $f(x, y)$ at $(0, 2)$.
   (a) What is the value of $f(0, 2)$?
   (b) In which direction does $f(x, y)$ increase the fastest at $(0, 2)$?
   (c) What is the directional derivative of $f(x, y)$ at $(0, 2)$ in the direction $\vec{v} = -\vec{i} - \vec{j}$?
   (d) If $x(t) = \sin t$ and $y(t) = 2e^t$, calculate $\dfrac{df}{dt}$ at $t = 0$.
2. (11 pts: 6, 5) Consider the function $f(x, y) = x^2 - 2x + y^2$.
   (a) Find and classify all critical points of $f(x, y)$.
   (b) Find the absolute maximum and absolute minimum values of $f(x, y)$ over $D = \{ (x, y) \,|\, x^2 + y^2 \le 4 \}$.
3. (8 pts) Consider the region in the xy–plane $D = \{ (x, y) \,|1 \le x \le e, 0 \le y \le \ln x \}$. Set up, but **do not evaluate**, two iterated integrals to find the area of D, one integrating x first and the other integrating y first.
4. (12 pts: 6 each) A solid E lies in the first octant below the cone $z = \sqrt{x^2 + y^2}$ and inside the cylinder $x^2 + y^2 = 1$. The density of E is given by $d(x, y, z) = z$. Set up, but **do not evaluate**, iterated integrals to find the total mass of E in the following coordinate systems.
   (a) The cylindrical coordinates.
   (b) The spherical coordinates.
5. (5 points) Show that the area of the region bounded by the ellipse $\dfrac{x^2}{a^2} + \dfrac{y^2}{b^2} = 1$ is πab.