As on the test: A correct answer, unsupported by calculations, explanation, or algebraic work will receive no credit; an incorrect answer supported by substantially correct calculations and explanations might still receive partial credit. Full credit will be given only for work that is presented neatly and logically.

Do not give numerical approximations to quantities such as \( \sin 5 \), \( \pi \), or \( \sqrt{2} \). However, you should simplify \( \cos \frac{\pi}{2} = 0, \ e^0 = 1 \), and so on. Any use of a calculator MUST be indicated.

(1) Find all the directions in which the directional derivative of \( f(x, y) = x^2 + y \) at the point \((1, 1)\) has the value 1.

(2) Find three positive numbers \( x, y, \) and \( z \) that maximize \( f(x, y, z) = x^2y^3z^4 \) and for which \( x + y + z = 9 \).

(3) Find the extreme values of \( h(x, y) = e^{-xy} \) on or inside the region \( 4x^2 + 9y^2 \leq 36, \ x \geq 0 \).

(4) Find the integral of the function \( f(x, y) = 2x\sqrt{y^2 - x^2} \) over the triangle \( T = \{(x, y) \mid 0 \leq y \leq 2, 0 \leq x \leq y\} \)

(5) Find the volume of the solid inside the sphere \( x^2 + y^2 + z^2 = 9 \) and outside the cylinder \( x^2 + y^2 = 1 \).

(6) Compute the surface area of the graph \( z = 1 + x^2 + y \) over the triangular region formed by the points \((0, 0), (3, 0), \) and \( (3, 2) \).

(7) Calculate the line integral \( \int_C xy\,ds \) if \( C \) is the portion of the unit circle in the first quadrant (i.e. \( x^2 + y^2 = 1 \) with \( x \geq 0, \ y \geq 0 \).