NAME _____

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(10) 1. Find the equation of the tangent plane to the graph of $f(x, y) = (x^2 + y^2)^2$ at the point $(1, 1, 4)$.

(10) 2. Express as a double integral the volume of region in the first octant bounded by the planes $x + z = 1$, $x = 0$, $y = 0, z = 0$, and $x + 2y = 1$. Show work but do not evaluate the integral.

$$ANSWER = \qquad \int \quad \int \qquad\qquad dx\,dy$$

(10) 3. Convert the following integral into cylindrical coordinates. Show work but do not evaluate the integral.

$$\int_{-2}^{2} \int_{0}^{\sqrt{4-x^2}} \int_{x}^{3+x^2+y^2} 10y\,dz\,dy\,dx$$

$$ANSWER = \qquad \int \quad \int \quad \int \qquad\qquad dz\,dr\,d\theta$$

(12) 4. Let $f(x, y) = x^3y$. Find the value of the directional derivative at (1,2) in the direction in which f increases most rapidly.

$ANSWER =$

(14) 5. Compute $\int_C \vec{F} \cdot d\vec{r}$ where C is the curve parametrized by $\vec{r}(t) = t\vec{i} + t\vec{j} + 2t\vec{k}$ for $0 \leq t \leq 1$, and $\vec{F}(x, y, z) = e^x\vec{i} + 3xy\vec{j} + xyz\vec{k}$.

$ANSWER =$

(16) 6. The function $f(x, y) = x^3/3 - 2xy + 2y^2 - 6x$ has two critical points. Find each one and determine if it is a relative maximum, minimum, or saddle point.

CRITICAL POINT (,) *IS A*
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(28) 7. Let D be the region bounded below by the cone $z = \sqrt{x^2 + y^2}$ and above by the sphere $x^2 + y^2 + z^2 = 9$. If $F(x, y, z) = xz$, express the integral $\iiint_D F\, dV$ as a triple integral in (a) rectangular coordinates, (b) cylindrical coordinates, and (c) spherical coordinates. Do not evaluate the integrals.

(a) Rectangular coordinates

(b) Cylindrical coordinates

(c) Spherical coordinates