[1] Evaluate \( \int_0^1 \int_{2y}^{2} \cos(x^2) \, dx \, dy \).

A) \sin(4) - \cos(4) + 1 \quad B) \frac{\sin(4)}{4} \quad C) \sin(1) \quad D) \sin(4) + \cos(4) - 1

[2] Which of the following is an equation for the plane through the point \((1, 1, -1)\) and parallel to the plane \(x - y + z = 3\)?

A) \(x + y - z = -1\) \quad B) \(x + y - z = 3\) \quad C) \(-x + y - z = 1\) \quad D) \(x - y + z = -3\)
[3] Evaluate \( \int_0^\sqrt{2} \int_0^x \sqrt{x^2+y^2} \, dy \, dx + \int_0^{\sqrt{2}} \int_0^{\sqrt{4-x^2}} \sqrt{x^2+y^2} \, dy \, dx \).

A) \( \frac{2\pi}{3} \) \quad B) \( \frac{\pi}{2} \) \quad C) \( \frac{\sqrt{2}\pi}{6} \) \quad D) \( \pi \)

[4] Let \( f(x, y) = \frac{x^2y}{x^4+y^2} \). Which of the following statements is true about \( \lim_{(x,y)\to(0,0)} f(x, y) \)?

A) \( \lim_{(x,y)\to(0,0)} f(x, y) \) does not exist because \( \lim_{x\to0} f(x, 0) \) does not exist.

B) \( \lim_{(x,y)\to(0,0)} f(x, y) = 0 \) because \( \lim_{x\to0} f(x, kx) = 0 \) for every \( k \).

C) \( \lim_{(x,y)\to(0,0)} f(x, y) \) does not exist because \( \lim_{x\to0} f(x, 0) \) is not equal to \( \lim_{x\to0} f(x, x^2) \).

D) \( \lim_{(x,y)\to(0,0)} f(x, y) \) does not exist because \( f(x, y) \) is undefined at \( (0,0) \).

[5] Find the unit tangent vector \( T(t) \) to the curve \( r(t) = \langle \sin t, 1+t, \cos t \rangle \) when \( t = 0 \).

A) \( \left\langle 0, \frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}} \right\rangle \) \quad B) \( \langle 0, 0, -1 \rangle \) \quad C) \( \left\langle \frac{-1}{\sqrt{2}}, \frac{1}{\sqrt{2}}, 0 \right\rangle \) \quad D) \( \left\langle \frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}, 0 \right\rangle \)

[6] A ball is thrown into the air with initial velocity \( \mathbf{v}(0) = 3\mathbf{i} + 8\mathbf{k} \). The acceleration is given by \( \mathbf{a}(t) = 8\mathbf{j} - 16\mathbf{k} \). How far away is the ball from its initial position at \( t = 1 \)?

A) \( 2\sqrt{3} \) \quad B) 3 \quad C) \( 4\sqrt{5} \) \quad D) 5
[7] Two right circular cylindrical storage tanks A and B have volume \( V = \pi r^2 h \) with height 25m and radius 5m. The radius of tank A is increased by a small amount while the height of tank B is increased by the same small amount. Which of the following statements is true?

A) The volume of tank A increased approximately 10 times more than the volume of tank B.

B) The volume of tank B increased approximately 10 times more than the volume of tank A.

C) The volume of tank A increased approximately 5 times more than the volume of tank B.

D) The volume of tank B increased approximately 5 times more than the volume of tank A.

[8] Rewrite \( \int_{-2}^{2} \int_{y^2}^{2} \int_{0}^{2-x/2} dz \, dx \, dy \) in \( dx \, dz \, dy \) order.

A) \( \int_{-2}^{2} \int_{y^2}^{2} \int_{0}^{2-x/2} dx \, dz \, dy \)  

B) \( \int_{-2}^{2} \int_{0}^{2-y^2/2} \int_{y^2}^{4} dx \, dz \, dy \)

C) \( \int_{-2}^{2} \int_{y^2}^{2} \int_{0}^{4-2z} dx \, dz \, dy \)

D) \( \int_{-2}^{2} \int_{0}^{2} \int_{y^2}^{4} dx \, dz \, dy \)

[9] Find the maximum rate of change of \( f(x, y) = x^2 - xe^{2y} \) at the point (2,0).

A) \( \sqrt{6} \)  

B) 3  

C) 5  

D) 6

[10] Suppose \( f(x, y) \) is a differentiable function of \( x \) and \( y \) and let \( g(r, s) = f(2rs, 8s - 2r) \). Use the table of values to calculate \( g_r(2,1) \).

\[
\begin{array}{|c|c|c|}
\hline
(x, y) & f & f_x & f_y \\
\hline
(2, 1) & 2 & -1 & 1 \\
(4, 4) & 3 & 2 & 3 \\
\hline
\end{array}
\]

A) 0  

B) 1  

C) -4  

D) -2
[11] In the figure below, straight lines represent level curves of a differentiable function \( f(x, y) \) and the ellipse represents the constraint \( g(x, y) = 0 \). The absolute maximum of \( f(x, y) \) subject to the constraint \( g(x, y) = 0 \)

A) could occur at point B but not at point A.
B) could occur at point A but not at point B.
C) could occur at point A and could occur at point B.
D) could not occur at point A and could not occur at point B.

[12] The absolute minimum of \( f(x, y) = x^2 + 4y^2 - 4y \) over the line segment \( x = 2 \) with \( 0 \leq y \leq 2 \) equals

A) 3 \hspace{1cm} B) -1 \hspace{1cm} C) 4 \hspace{1cm} D) 0

[13] Rewrite \( \int_0^{2\pi} \int_{\pi/4}^{3\pi/4} \int_{\sqrt{2}}^{\sqrt{2-r^2}} r \ dz \ dr \ d\theta \) in spherical coordinates.

A) \( \int_0^{2\pi} \int_{\pi/4}^{3\pi/4} \int_{1/\cos\phi}^{\sqrt{2}} \rho^2 \sin \phi \ d\rho \ d\phi \ d\theta \) \hspace{1cm} B) \( \int_0^{2\pi} \int_{\pi/4}^{3\pi/4} \int_{1/\sin\phi}^{\sqrt{2}} \rho^2 \sin \phi \ d\rho \ d\phi \ d\theta \)

C) \( \int_0^{2\pi} \int_{\pi/4}^{3\pi/4} \int_0^{\sqrt{2}} \rho^2 \sin \phi \ d\rho \ d\phi \ d\theta \) \hspace{1cm} D) \( \int_0^{2\pi} \int_{\pi/4}^{3\pi/4} \int_1^{\sqrt{2}} \rho^2 \sin \phi \ d\rho \ d\phi \ d\theta \)