1. (9 points) Find an equation of the plane that contains the line $\mathbf{r}(t) = \langle 1, 0, 1\rangle + t\langle -1, 1, 2\rangle$ and the origin.

A. $-x + 4y + z = 0$

B. $4x + 2x - 4z = 0$

C. $-x - 3y + z = 0$

D. $x + y - z = 0$

E. $2x + 3y - 2z = 0$

2. (9 points) Find the curvature of the helix

$$\mathbf{r}(t) = \langle \cos t, \sin t, t\rangle.$$

Recall: $\kappa = \dfrac{|\mathbf{T}'|}{|\mathbf{r}'|}$

A. $2\sqrt{2}$

B. $1/2$

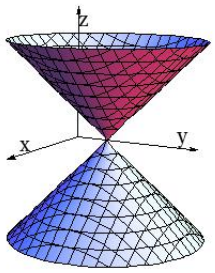
C. $\sqrt{2}$

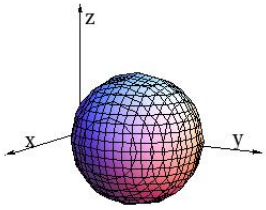
D. $\sqrt{2}/2$

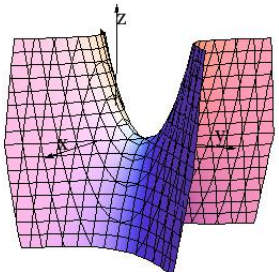
E. 1

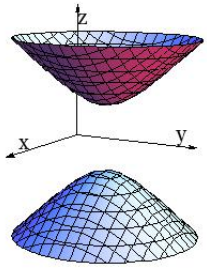
3. (9 points) Which of the graphs below is the graph of the given equation?

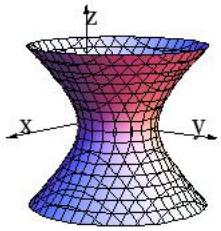
$$x^2 + y^2 - z^2 - 2y = 0$$

A. 

B. 

C. 

D. 

E. 

4. (9 points) Use the linearization of $f(x,y) = \sqrt{x^2+y^2}$ at (3,4) to approximate the number $\sqrt{(3.1)^2+(3.8)^2}$.

A. 4.84

B. 4.86

C. 4.88

D. 4.90

E. 4.92

5. (8 points) Find all possible values of a so that the angle between the vectors

$$\mathbf{a} = \left\langle \frac{1}{\sqrt{2}}, 0, \frac{1}{\sqrt{2}} \right\rangle, \mathbf{b} = \langle 0, a, 1 \rangle$$

is $\pi/3$.

6. (10 points) Find parametric equations for the tangent line to the curve

$$\mathbf{r}(t) = \langle \sin(2\pi t), t^2 + 2t, \arctan(t) \rangle$$

at the point $(0, 3, \pi/4)$.

7. (12 points) A particle is moving in space with acceleration

$$\mathbf{a}(t) = \pi^2 \cos(\pi t)\hat{\mathbf{i}} + \frac{1}{(t+1)^2}\hat{\mathbf{j}} + e^{t/2}\hat{\mathbf{k}}.$$

Assume the particle is initially at rest (that is, it has no initial speed) and its initial position is the origin. What is the particle's position at $t = 1$?

8. (8 points) Sketch the domain of

$$f(x, y) = \sqrt{xy - 1}.$$

Circle your answer.

9. (8 points) Find the limit, if it exists, or show that the limit does not exist. If the limit does not exist, write DNE in the box.

$$\lim_{(x,y)\to(0,0)} \frac{x^2 y e^y}{x^4 + 4y^2}$$

10. (8 points) Let $f(x, y) = \cos(\pi x^2 - 3xy)$. Find an equation of the plane tangent to the graph of f at the point $(1, \pi/4, \sqrt{2}/2)$.

11. (10 points) **Ohm's Law** for a simple electric circuit is

$$V = IR$$

where V is the voltage (in volts), I is the current (in amperes), and R is the resistance (in ohms). In a simple circuit, suppose $R = 4\ \Omega$ (Ω is the symbol for ohms), $I = 5$ A, the voltage is decreasing at 1 V/s, and the resistance is increasing at 3 Ω/s. At what rate is the current I changing?