Show your work to receive any credit. Problems 1 to 4 are 17 points each. Problems 5 and 6 are 16 points each.

1. Find the equation of the tangent plane to the surface
$$f(x, y) = 9 + x^2 - 2y \qquad \text{at the point } (2, 2, 9).$$

2. The point $(0, 0)$ is a critical point for the function $f(x, y) = 3x^2 - \cos(y)$.
Use the second derivative test to determine whether
this point is a local maximum, local minimum or saddle point.

3. Compute $D_{\mathbf{u}} f(0, 1)$ for $\mathbf{u} = \left\langle \frac{1}{\sqrt{5}}, \frac{2}{\sqrt{5}} \right\rangle$ and for $f(x, y) = \sin(xy)$.
Your answer should be a number.

4. The function $f = f(x, y) = x^3y^2$ is a function of x and y, and $x = u^2 - v^2$ and $y = u^2 + v^2$ are in turn functions of u and v.
Compute $\frac{\partial f}{\partial u}$ by using a version of the chain rule. Express your answer in terms of u and v.

5. Find the equation of the plane that contains the points $(1, 1, 1)$, $(2, 2, 3)$ and $(1, 1, 2)$.

6. Find the angle between the vectors $\langle 1, 1, 0\rangle$ and $\langle 0, 1, 1\rangle$.
Express your answer in radians.

Extra Credit: (5 points)

Pictured below are level curves for a function $f(x, y)$ and four vectors, **A**, **B**, **C**, and **D**. Which of these four vectors could represent $\nabla \mathbf{f}(\mathbf{P})$?