1. (10 pts.) Find the equation of the plane which contains the point \((2, 1, -1)\) and is perpendicular to the planes \(3x + y - z = 6\) and \(2x + 2y + z = 4\).

2. (12 pts.)
   (a) Sketch the domain of \(f(x, y) = \sqrt{1 - x^2} + \sqrt{4 - y^2}\).
   (b) What is the range of \(f\)? Support your answer!

3. (10 pts.) Does \(\lim_{(x,y)\to(0,0)} \frac{xy}{x^2 + xy + y^2}\) exist? Why or why not?

4. (10 pts.) For what value(s) of the constant \(a\), if any, does \(u(x, y) = e^{2x} \cos(ay)\) satisfy Laplace’s equation \(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0\)?

5. (10 pts.) Find the equation of the plane tangent to the surface \(x^2 + xy - yz^3 + z = 6\) at the point \((2, 1, 1)\).

6. (12 pts.)
   (a) Define: \(f(x, y)\) is differentiable at a point \((a, b)\).
   (b) Use the definition to prove that \(f(x, y) = xy\) is differentiable at every point \((a, b)\).

7. (10 pts.) Find parametric equations of the line tangent to the curve \(x = t^2 - 1, y = 2t, z = t^2 + 1\) at the point \((3, -4, 5)\).

8. (12 pts.) For \(f(x, y) = x^2 + 3xy - y^2\),
   (a) What is the directional derivative of \(f\) at \((1, 2)\) in the direction from \((1, 2)\) to \((4, 6)\)?
   (b) For what unit vector \(\vec{u}\) is the direction derivative \(D_{\vec{u}} f(1, 2)\) largest?

9. (14 pts.) Suppose that \(z = f(x, y)\) where \(x = 2u + 3v\) and \(y = 3u - 2v\), and that \(f\) has continuous second partials.
   (a) Find \(\frac{\partial z}{\partial u}\) in terms of the partial derivatives of \(f\) (in other words, in terms of \(\frac{\partial z}{\partial x}\) and \(\frac{\partial z}{\partial y}\)).
   (b) Find \(\frac{\partial^2 z}{\partial u^2}\) in terms of the first and/or second partial derivatives of \(f\).