Show all of your work. Full credit will be given only for answers with explanations.

1. (50 points) Check all the correct statements.

   ○ The tangent plane of the function \( f(x, y) = xe^y + ye^x \) at \((1, 1, 2e)\) is defined by the equation \(2ex + 2ey = z + 2e\).

   ○ The angle between \( \frac{\partial f}{\partial x}(\pi, 0) \) and \( \frac{\partial f}{\partial y}(\pi, 0) \) is \( \pi/2 \), where \( f(x, y) = \langle \cos(x) + \sin(y), \sin(x) + \cos(y) \rangle \).

   ○ If \( z = x^2 + y^2 \), \( x = \sin(t) \), and \( y = \cos(t) \), then \( \frac{dz}{dt} = 0 \).

   ○ The tangent planes of \( f(x, y) = x^2 + y^2 \) at \((1, 0, 1)\) and \((0, 1, 1)\) are parallel.

   ○ The vector \((1, -1, 1)\) is perpendicular to \( \frac{df(\pi)}{dt} \) and \( \frac{df(\pi/2)}{dt} \), where \( f(t) = \langle \cos(t), \sin(t), t \rangle \).
2. Let \( r = (x^y, y^x) \), where \( x = e^t \), and \( y = t^2 \).

(a) (5 points) Find \( \frac{dr}{dt} \).

(b) (5 points) Find the tangent line of the curve described by the vector function \( r \) for \( t = 1 \).
3. Let $f(x, y) = xy^2 + yx^2$.
   (a) (5 points) Find the tangent planes to the surface defined by $f$ at $(1, 1, 2)$ and $(-1, -1, -2)$.

   (b) (5 points) Check if these planes are intersecting; if they are intersecting, find symmetric equations for the line of intersection of the planes.
4. Let us consider a surface defined implicitly by the equation \( x^3 + y^3 + z^3 + 6xyz = 1 \). Find the tangent plane of the surface at \((1, -3, -3)\).