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

1. (10 points) Find the maximum and minimum values of \( f(x, y) = 4x^2 + 10y^2 \) on the disk \( x^2 + y^2 \leq 4 \).
2. (10 points) Find $\int\int_{R} x^2 + y^2 + xy\,dA$, where $R = [0,1] \times [1,2]$. 
3. Consider the plane $P$ with equation $z = 6x - 3y + 2$.

(a) (10 points) Find the equation of a plane parallel to $P$ and passing through the point $(1, 0, -1)$.

(b) (10 points) For which value of $a$ is the vector $\langle -2, 1, a \rangle$ normal to the plane?
4. Let $f(x, y) = \sin(x) + \sin(y)$.
   
   (a) (5 points) Find the tangent planes at $\langle \pi, \pi, 0 \rangle$ and $\langle \pi/2, \pi/2, 2 \rangle$.

   (b) (5 points) Check if these planes are intersecting; if they are intersecting, find symmetric equations for the line of intersection of the planes.
5. Let \( f(x, y) = 2xy \) and \( g(x, y) \) be the maximum value of \( D_u f(x, y) \) over all unit vectors \( u \).

(a) (10 points) Find the value of \( g(1, 3) \).

(b) (10 points) Find and classify all the critical points of \( g(x, y) \).
6. Let \( r = (u + v, u + v^2, u^2 + v) \), where \( u = \cos(x) + \cos(\pi \cdot y) \) and \( v = \sin(xy) \).

(a) (5 points) Find \( \frac{\partial r}{\partial x} \) and \( \frac{\partial r}{\partial y} \).

(b) (5 points) Find the tangent plane of the surface described by the vector function \( r \) for \( x = \frac{\pi}{2} \) and \( y = 1 \).
7. (10 points) Find the linear approximation of the function \( f(x, y) = x^2 + yx \) at \((1, -1)\).