① If $f(x,y) = \sqrt{4 - x^2 - 4y^2}$, find $f_x(1,0)$ and $f_y(1,0)$ and interpret as slopes.

② Verify that $u_{xy} = u_{yx}$ for $u(x,y) = x \sin(x + 2y)$

③ Which is a solution to Laplace's PDE $u_{xx} + u_{yy} = 0$

a) $u = x^2 + y^2$

b) $u = x^2 - y^2$

c) $u = \sin(x) \cosh(y) + \cos(x) \sinh(y)$

d) $u = e^{-x} \cos(y) - e^{-y} \cos(x)$

④ Show that $u = \frac{1}{a^2 t^2 - x^2}$ solves the Wave Equation $u_{tt} = a^2 u_{xx}$

⑤ How many n-th order partial derivatives does a function $f(x,y)$ have?

⑥ Find equation of the tangent plane to the given surface at the specified point:

a) $z = y \ln(x)$ at $(1,4,0)$

b) $z = \sqrt{xy}$ at $(1,1,1)$

⑦ Graph the surface and its tangent plane at the given point using Maple:
$$z = x^2 + xy + 3y^2 \text{ at } (1,1,5)$$

⑧ Find the directional derivative of $f(x,y)$ at the given point in the direction indicated by $\theta$:

a) $f(x,y) = x^2 y^3 - y^4$, $P(2,1)$, $\theta = \pi/4$

b) $f(x,y) = x \sin(xy)$, $P(2,0)$, $\theta = \pi/3$

⑨ Find the gradient of $f$ at the point $P$:

a) $f(x,y) = y^2/x$, $P(1,2)$

b) $f(x,y,z) = \sqrt{x+yz}$, $P(1,3,1)$

⑩ Find the directional derivative $D_v(f)$:

a) $f(x,y) = \ln(x^2 + y^2)$, $\vec{v} = \langle -1, 2 \rangle$

b) $f(x,y,z) = (x + 2y + 3z)^{3/2}$, $\vec{v} = 2\vec{j} - \vec{k}$