Problem 1. ________
Problem 2. ________
Problem 3. ________
Problem 4. ________
Problem 5. ________
Total. ________
Problem 1. (8 points) Consider a particle traveling according to the equations

\[ x(t) = \cos^2 t, \quad y(t) = \cos t. \]

Write down and simplify (but do not evaluate) the formula for the length of the curve along which the particle is moving.
Problem 2. (10 points) Consider a particle whose velocity, at time $t \geq 0$, is given by 
\[ \vec{v}(t) = (-2t, -\sin t) \]
and whose position at $t = 0$ is $(4, 0)$.

a. (6 points) Find the formula for the position of the particle at time $t$.

b. (4 points) Find the point at which the particle crosses the $y$ axis.
Problem 3. (12 points) Find the equations of the normal and of the osculating planes to the curve
\[ \vec{r}(t) = \langle t^3, \sin(\pi t), t + 1 \rangle \]
at the point corresponding to \( t = 2 \).
Problem 4. (8 points) Identify the curve

\[ r = 2 \sin \theta + 2 \cos \theta \]

by finding a Cartesian equation for the curve. Give a verbal description of what that curve is.
Problem 5. (12 points) Consider the function of two variables

\[ f(x, y) = \sqrt{1 + x - y^2}. \]

a. (4 points) Identify and sketch the domain of \( f(x, y) \).

b. (4 points) Find the partial derivative \( f_y(x, y) \).

c. (4 points) Find the second partial derivative \( f_{xy}(x, y) \).