1 (15 points). Find $f(t)$ from the following information

$$f'(t) = t \sin(t)i + \frac{2}{\sqrt{4 - t^2}}j - \frac{1}{t-2}k, \quad \text{and} \quad f(0) = j - k.$$ 

Multiple choice hint: $\cos^{-1}(u), \sin^{-1}(u), \tan^{-1}(u)$ and integration by parts.
2 (5 points). Find \( \lim_{t \to 0} f(t) \) if it exists

\[
f(t) = 2t^2 + t \sin(t) i + t^2 \left( 1 + \frac{1}{t^2} \right) k
\]
3 (15 points). Find

\[
\frac{d}{dt} \left[ \left( \ln t \mathbf{i} + \frac{t^2}{2} \mathbf{j} - (t^2 - 1) \mathbf{k} \right) \times \left( \frac{1}{t} \mathbf{i} + t \mathbf{j} - \mathbf{k} \right) \right] \quad \text{at} \quad t = 1.
\]
4 (10 points). Find the tangent and acceleration vectors and the equation for the tangent line at $t = \pi/6$:

$$\mathbf{r}(t) = \cos(2t)i - \sin(t)j + \ln(t)k$$
5 (10 points). Sketch the plane curve and indicate its orientation. Find the unit tangent and unit normal at the indicated point:

\[ \mathbf{r}(t) = e^{-2t} \mathbf{i} + e^{2t} \mathbf{j} \text{ at } t = 0. \]
6 (15 points). Find the length of the arc:

\[ \mathbf{r}(t) = (t \sin t + \cos t)\mathbf{i} + (t \cos t - \sin t)\mathbf{j} + 102\mathbf{k} \quad \text{from} \quad t = 0 \quad \text{to} \quad t = 2\pi. \]
7 (10 points). Identify and sketch the surface

\[9y^2 - 4y^2 - 36z^x = 36\]

\[(y - 1)^2 + (z + 1)^2 = 4\]
8 (10 points). What space curve(s) do the given two surfaces $4x^2 + 4y^2 + (z - 2)^2 = 16$ and $x^2 + y^2 - z = 2$ intersect in?


9 (10 points). Identify the level curves of \( f(x, y) = c \) and sketch them:

\[
f(x, y) = \ln \left( \frac{x}{y^2} \right), \quad c = -1, 0, 1, 2
\]
10 (10 points). Find the equation for the level surface of \( f(x, y, z) = x^2 + y^2 - 4z \) that contains the given point \( P(1, 1, 0.5) \) and identify and sketch it.
11 (10 points). Find $f_x(x, y)$ and $f_y(x, y)$ by forming the appropriate difference quotient and taking the limit as $h \to 0$: $f(x, y) = e^{3x}y^2$. 
12 (5 points). Find $f_x(0, e)$ and $f_y(0, e)$ given that $f(x, y) = \ln(x/y) - ye^{2x}$.

13 (10 points). Let $f(x, y)$ be differentiable everywhere with

$$f_x(x, y) = y + x^2, \quad f_y(x, y) = x + e^y.$$ 

Does such $f$ exist?
14 (Bonus: 15 points). Let \( z = x^2 + y^2 \), and \( C \) be the line of intersection of the surface with plane \( y = 3 \). Find the equation for the tangent line to \( C \) at the point \((1, 3, 10)\).