1. (a) (7 points) HINT: \( r'(2) = \langle 4, -2, 6 \rangle \) and \( r''(2) = \langle 2, 1, 1 \rangle \).
   ANSWER: \( a_T = \frac{12}{\sqrt{56}} \) and \( a_N = \frac{8\sqrt{3}}{\sqrt{56}} \).

(b) (3 points) ANSWER: \( 4(x - 4) - 2(y + 5) + 6(z - 10) = 0 \) OR \( 4x - 2y + 6z = 86 \) OR \( 2x - y + 3z = 43 \).

2. (a) (4 points) HINT: \( f_y(x, y) = -e^{-xy}(\sin y + x \cos y) \)
   ANSWER: \( f_{yx}(x, y) = -e^{-xy}(\cos y - y \sin y - xy \cos y) \).

(b) (4 points) HINT: \( f_x(x, y) = -ye^{-xy} \cos y \). So, \( f_x(\pi, 0) = 0 \) and \( f_y(\pi, 0) = -\pi \). The tangent plane is the plane with normal vector \( \langle 0, -\pi, 1 \rangle \) that contains the point \( (\pi, 0, f(\pi, 0)) = (\pi, 0, 1) \).
   ANSWER: \( -\pi(y - 0) - 1(z - 1) = 0 \) OR \( z = 1 - \pi y \).

(c) (2 points) ANSWER: \( f(3.15, 0.001) \approx 1 - 0.001 \pi \approx 0.9968584 \).

3. (a) (8 points) HINT: \( g_x(x, y) = x + y - 3 \) and \( g_y(x, y) = x + y^2 - 3 \).
   ANSWER: There is a saddle point at \( (3, 0) \) and a local minimum at \( (2, 1) \).

(b) (2 points) HINT: \( g(x, 0) = \frac{1}{2} x^2 - 3x \), a quadratic whose graph is a parabola that opens up. Its vertex occurs at \( x = 3 \).
   ANSWER: \( g(3, 0) = -\frac{9}{2} \).

4. HINT: You must change the order of integration! With the current order, you have \( 0 \leq x \leq \sqrt{\pi/2} \) and \( x \leq y \leq \sqrt{\pi/2} \). This means, the region over which you are integrating is the triangle bounded on the left by the \( y \)-axis \( (x = 0) \), below by the line \( y = x \) and above by the line \( y = \sqrt{\pi/2} \).

Then, we have:
\[
\int_0^{\sqrt{\pi/2}} \int_x^{\sqrt{\pi/2}} \cos(y^2) \, dy \, dx = \int_0^{\sqrt{\pi/2}} \int_0^{y} \cos(y^2) \, dx \, dy.
\]

ANSWER: \( \frac{1}{2} \).

5. HINT: Convert to polar:
\[
\int_D \frac{xy e^x}{(x^2 + y^2)^{3/2}} \, dA = \int_0^{\pi/2} \int_0^3 \cos \theta \sin \theta e^r \cos \theta \, dr \, d\theta.
\]

ANSWER: \( \frac{1}{3} e^3 - \frac{4}{3} \).