FRAME YOUR FINAL ANSWER(S) TO EACH PROBLEM
Do not write below this line

1. (out of 10)
2. (out of 10)
3. (out of 10)
4. (out of 10)
5. (out of 10)
6. (out of 10)
7. (out of 10)
8. (out of 10)
9. (out of 10)
10. (out of 10)

Types: Number, Function of variable(s), 2D vector of numbers, 3D vector of numbers, 2D vector of functions, 3D vector of functions, equation of a plane, parametric equation of a line, equation of a line, equation of a surface, equation of a line, DNE (does not exist).
1. (10 pts.) Find, as a function of \( t \), the curvature of the curve

\[ \mathbf{r}(t) = (e^t, t, e^{2t}) \]

The *type* of the answer is:
2. (10 points) Find $\frac{\partial h}{\partial r}$ at $(q, r) = (3, 2)$ where $h(u, v) = ve^u$, $u = q^2$, $v = q^2 r$

The type of the answer is:
3. (10 points) Find $a_T$ and $a_N$ as a function of $t$ if $\mathbf{r}(t) = (t, \cos t, \sin t)$.

The type of the answer is:
4. (10 points) Find an equation of the tangent plane at the given point 

\[ z = xy \ln(x + y) \text{ , } (1, 1) \text{ .} \]

The **type** of the answer is:
5. (10 points) Find $\frac{\partial f}{\partial s}$ at $(r, s) = (1, 0)$, where $f(x, y) = \ln(xy)$, $x = 3r + 2s$, and $y = 5r + 3s$.

The type of the answer is:
6. (10 points) Find \( \frac{\partial z}{\partial x} \) and \( \frac{\partial z}{\partial y} \) if

\[
x^3 + y^3 + z^3 = 2xyz + 1
\]

The type of the answer is:
7. (10 points) Describe the vertical and horizontal traces of \( f(x, y) = 9 - x^2 - y^2 \). Sketch a few of them.

**Type of answers:** Families of curves in \( xy \)-plane, \( xz \)-plane, and \( yz \)-plane. Diagrams.
8. (10 points) Find the length of the curve

\[ r(t) = (1, 3e^t, 4e^t) \quad 0 \leq t \leq \ln 3 \]

The type of the answer is:
9. (10 points) Which of the following is the arc length parametrization of a circle of radius 10 centered at (1, 2). Explain!

(a) \( \mathbf{r}_1(t) = \langle 1 + 10 \cos t, 2 + 10 \sin t \rangle \)

(b) \( \mathbf{r}_2(t) = \langle 1 + 10 \cos 10t, 2 + 10 \sin 10t \rangle \)

(c) \( \mathbf{r}_3(t) = \langle 1 + 10 \cos \frac{t}{10}, 2 + 10 \sin \frac{t}{10} \rangle \)

(d) \( \mathbf{r}_4(t) = \langle 1 + 10 \cos 5t, 2 + 10 \sin 5t \rangle \)

(e) \( \mathbf{r}_5(t) = \langle 10 \cos t, 10 \sin t \rangle \)
10. (10 points) Find an equation to the plane that passes through the points \((1, 2, 3)\), \((2, 1, 3)\), \((3, 2, 1)\).

The type of the answer is:
Answers
1. \[ e^{\sqrt{1+16e^{2t}+4e^{4t}}} \left( \sqrt{1+e^{2t}+4e^{4t}} \right)^3 \] (type: Function of \( t \)).
2. \( 9e^9 \) (type: Number). [Thanks to Sammy G. for the correction!]
3. 0 and 1 (types: functions of \( t \) that happen to be constant functions (by accident)).
4. \( z = (\ln 2 + \frac{1}{2})x + (\ln 2 + \frac{1}{2})y - (\ln 2 + 1) \) (type: Equation of Plane).
5. \( \frac{19}{15} \) (type: Number).
6. \(-\frac{3x^2-2yz}{3z^2-2xy}, -\frac{3y^2-2xz}{3z^2-2xy}\) (type: functions).
7. \( x^2 + y^2 = 9 - c \) (type: family of circles in \( xy \)-plane); \( z = 9 - c^2 - y^2 \) (type: family of parabolas in \( yz \)-plane); \( z = 9 - c^2 - x^2 \) (type: family of parabolas in \( xz \)-plane);
8. 10 (type: Number).
9. (c) (because the magnitude of \( r_3'(t) \) is always 1.
10. \( x + y + z = 6 \) (type: Equation of plane).