(1) (20 pts.) Items (a) – (e) refer to the two vectors
\[ \mathbf{u} = \langle 2, 2, 1 \rangle \]
\[ \mathbf{v} = \langle -2, 1, 1 \rangle \]

(a) Find the unit vector in the direction of \( \mathbf{u} \).
(b) Find \( \mathbf{u} \cdot \mathbf{v} \).
(c) Find \( \mathbf{u} \times \mathbf{v} \).
(d) Find \( \text{proj}_\mathbf{v} \mathbf{u} \), the vector projection of \( \mathbf{u} \) onto \( \mathbf{v} \).
(e) Find the area of the parallelogram determined by \( \mathbf{u} \) and \( \mathbf{v} \).
(2) (20 pts.) Items (a) and (b) refer to the point \( A = (1, -1, -1) \) and the plane \( \mathcal{P} \) defined by the equation \( 2x - 4y - z = 3 \).

(a) Find the distance from the point \( A \) to the plane \( \mathcal{P} \).

(b) Find the equation of the line that passes through the point \( A \) and is perpendicular to the plane \( \mathcal{P} \).

(c) Find the equation of the plane that passes through \( A \) and is parallel to the plane \( \mathcal{P} \).
(3) (10 pts.) For the parametric space curve \( \mathbf{r}(t) = \langle t^2, e^{1-t}, t^{-2} \rangle \), find parametric equations for the line that is tangent to the curve when \( t = 1 \).

(4) (20 pts.) For the parametric plane curve \( \mathbf{r}(t) = \langle e^{-t} + 1, e^t \rangle \), find the unit tangent vector function \( \mathbf{T}(t) \) and the unit normal vector function \( \mathbf{N}(t) \).
(5) (20 pts.) For the parametric space curve \( \mathbf{r}(t) = \langle t, 2t^{3/2}, -t \rangle \), find the unit tangent vector function \( \mathbf{T}(t) \) and the length of the curve for \( 0 \leq t \leq 1 \).

(6) (10 pts.) Items (a) – (h) are equations that define surfaces in \( \mathbb{R}^3 \). Here is a list containing descriptors of these eight surfaces.

- hyperboloid of one sheet
- plane
- cylinder
- hyperboloid of two sheets
- paraboloid
- cone

Match each equation with the corresponding descriptor of that surface.

(a) \( x^2 = 2y^2 + 2z^2 \)  
(b) \(-x^2 - 2y^2 + 2z^2 = 1 \)
(c) \( x = 2y^2 + 2z^2 \)  
(d) \( x = 2y^2 - 2z^2 \)
(e) \( 2y^2 + 2z^2 = 1 \)  
(f) \( x + 2y + 2z = 1 \)
(g) \( x^2 + 2y^2 + 2z^2 = 1 \)  
(h) \(-x^2 + 2y^2 + 2z^2 = 1 \)