

SHOW YOUR WORK COMPLETELY AND NEATLY.
DON'T WRITE MORE THAN YOU NEED TO.

Total points = 40.

1. Let γ be the parametric curve in \mathbb{R}^3 defined by

$$\gamma(t) = (\sin(t), \cos(t), t) \quad \text{for } t \in \mathbb{R}.$$

- a) (2 points) Calculate the speed of γ .
 - b) (12 points) Calculate the Frenet frame (T, P, B) for γ at the point $\gamma(\pi/4)$.
 - c) (11 points) Directly from your calculations done for part b) calculate the curvature and torsion of γ at the point $\gamma(\pi/4)$.
2. a) (3 points) Define carefully what is meant by a regular parametric surface.
- b) (9 points) Let $U = \mathbb{R}^2$ and let ϕ be the function from U to \mathbb{R}^3 defined by

$$\phi(x, y) = (xe^y, ye^x, e^x).$$

Verify that ϕ is a regular parametric surface.

- c) (3 points) Find a basis for the tangent space to this surface at the point $\phi(1, 1)$. Justify your answer.