

INSTRUCTIONS: Write your name and your instructor's name on the front of your work. Work all problems. Show your work clearly. Note that a correct answer with incorrect or no supporting work may receive no credit, while an incorrect answer with relevant work may receive partial credit.

1. (20 points) The powerful math wizard, Algebrus Dumbledore, is creating mystical curves and surfaces for his class. He begins by creating a plane that includes the points $A(1, 0, 1)$, $B(2, 2, 1)$, and $C(1, 2, 2)$. He then creates the line $\frac{1-x}{2} = 1 - y = \frac{z-2}{2}$.

- (a) Find the equation of the plane.
(b) Find the angle the line hits the plane.

2. (30 points) A Calc 3 space cadet is traveling along the path

$$\mathbf{C}(t) = \langle t^2, 9 + t, \sqrt{6}t^{\frac{3}{2}} \rangle, \quad t \geq 0$$

while Darth Mathious pursues along the path

$$\mathbf{D}(t) = \left\langle \frac{t^3}{3}, 4t, \sqrt{2}t^2 \right\rangle, \quad t \geq 0.$$

- (a) Where, if at all, would Darth Mathious intercept the space cadet?
(b) Darth Mathious only has enough fuel to travel $\frac{32}{3}$ space units. Where is his ship when he runs out of fuel? Does he have enough fuel to capture the space cadet (provided his path allows him)? *Hint:* If you are having trouble solving for the time, try plugging in some integers to get you started and note $t^3 + 12t - 32 = 0$ only has one real root.

3. (30 points) Mathy McFly is in his time-traveling flying car trying to get back to the future. He follows the path

$$\mathbf{r}(t) = \langle \cos(2t), -\sin(2t), 4t \rangle, \quad t \geq 0$$

to avoid some flying debris. At time $t = \pi$ seconds a straight path opens up in the direction he is headed. He maintains his speed for another π seconds before he time-travels.

- (a) What is the curvature, $\kappa(t)$, of the path with $0 \leq t \leq \pi$?
(b) At what time(s), if any, with $0 \leq t \leq \pi$ is the unit normal vector of the path parallel to the line parameterized by $\mathbf{L}(t) = \langle 1 + \sqrt{2}t, 2, 2 \rangle$?
(c) Where is Mathy when he time-travels?

4. (20 points) Mathy McFly has arrived to the future at the (unrelated from problem 3) point $\mathbf{r}(0) = \langle 0, 0, 10 \rangle$. His on board navigation system logs his velocity as

$$\mathbf{v}(t) = \langle 2, 2t, t^2 \rangle, \quad t \geq 0.$$

- (a) What is the vector function for position?
(b) What are the tangential and normal components of acceleration?