

**Quiz 1;** Wednesday, January 27  
**MATH 53** with Professor Stankova  
**Section 109;** 11-12  
**GSI:** Eric Hallman

**Student name:**

You have 10 minutes to complete the quiz. Calculators are not permitted, and remember to show your calculations and explain your reasoning in order to receive full credit.

1. Find all times  $t$  where the tangent line to the curve given by  $x = t^2$ ,  $y = \cos t$  is horizontal or vertical.

SOLUTION: First find the equation for the slope of the tangent line in terms of  $t$ :

$$dy/dx = \frac{dy/dt}{dx/dt} = \frac{-\sin t}{2t}.$$

The numerator is zero whenever  $t$  is a multiple of  $\pi$  and the denominator is zero only when  $t = 0$ . To find the slope of the tangent line at  $x = 0$ , use L'Hospital's Rule:

$$\lim_{x \rightarrow 0} \frac{-\sin t}{2t} = \lim_{x \rightarrow 0} \frac{-\cos t}{2} = -1/2.$$

At  $x = 0$ , the slope of the tangent line is neither horizontal nor vertical. There are therefore no vertical asymptotes, and there are horizontal asymptotes whenever  $t = k\pi$ , where  $k$  is a non-zero integer.

ROUGH RUBRIC: 6 points for finding the general formula for  $dy/dx$ , 5 for getting the horizontal asymptotes, 4 for the vertical asymptotes.

11/15 for failing to use L'Hospital's rule to determine the slope at  $t = 0$ .

13/15 for using L'Hospital's rule to say that  $t = 0$  was not a vertical asymptote but failing to specify  $t \neq 0$  for the horizontal asymptotes.

No points off for failing to list negative times since the quiz did not properly specify the domain of  $t$ .