

1. The following four problems are not related. (*Reminder:* You may not use L'Hopital's Rule or "dominance of powers" arguments for any problem on this exam.)

(a) (10 pt) Find the value of $\lim_{t \rightarrow \infty} \frac{t^{-1} - t^{3/2} + 2}{t^{-1} + 5\sqrt{t^3} + 4}$ or explain why the limit does not exist.

(b) (10 pt) Let $h(x) = \frac{7 \sin x}{9x + \sin x}$. Find $h'(\pi)$. Fully simplify your answer.

(c) (10 pt) Find dy/dx given $\frac{3}{4}(x + y)^{4/3} = 1 + x^2y$.

(d) (10 pt) Let $f(x) = |x| - x^3$.

i. Write the limit definition of $f'(a)$, the derivative of $f(x)$ at $x = a$.

ii. Use the limit definition to find the value of $f'(0)$ if it exists, or show why it does not exist.

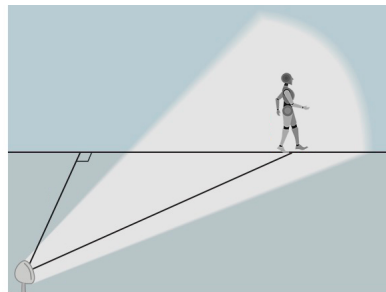
2. (18 pt) Let $g(x) = \frac{x^2 + 16}{3 - x}$.

(a) Does the graph of $g(x)$ have any vertical asymptotes? If so, find the asymptotes and justify your answer using limits. If not, explain why not.

(b) Find all critical numbers of $g(x)$, if any.

3. (10 pt) The line $y = -6x + 17$ is tangent to $y = bx^3 + c$ at $(2, 5)$. Find the values of the constants b and c .

4. (14 pt) A light is located on the ground 12 ft from a straight path. A robot begins walking along the path at a speed of 5 ft/sec, starting from the point on the path closest to the light. At what rate is the distance between the robot and the light changing when the robot is 16 ft from its starting point?



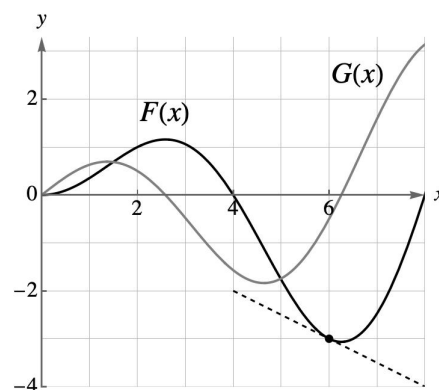
5. (18 pt) The graphs of functions $F(x)$ and $G(x)$ are shown below, along with the line tangent to $y = F(x)$ at $x = 6$. The tangent line passes through three grid intersection points.

- (a) Find the linear approximation of $F(x)$ centered at $a = 6$.
Use it to approximate the value of $F(5.96)$.

- (b) The line tangent to $y = G(x)$ at $x = 4$ has the equation $\pi x + 4y = 2\pi$. Find

$$\lim_{h \rightarrow 0} \frac{G(4+h) + \pi/2}{h}$$

or explain why the limit does not exist.



- (c) One of the two functions shown is the derivative of the other. No justification is necessary for parts (i)–(ii).

i. Which function (F or G) is the derivative? _____

ii. For each statement below, write the word True or False.

- _____ $F'(a) = G(a)$ for every a in the domain of both functions.
- _____ $G'(a) = F(a)$ for every a in the domain of both functions.
- _____ $dF/dx > 0$ on every interval where $G > 0$.
- _____ $dG/dx < 0$ on every interval where $F < 0$.