

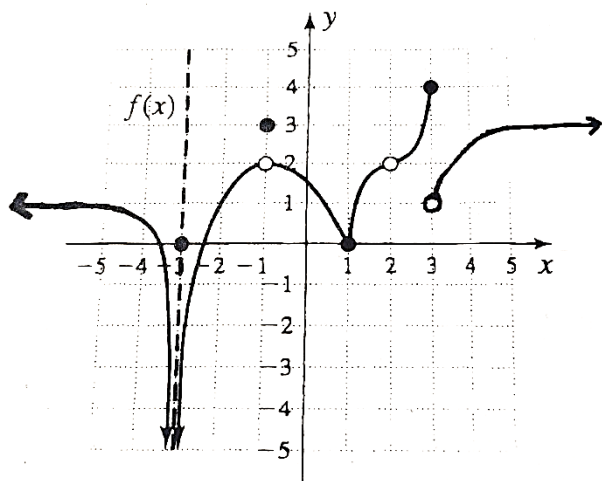
QUEENS COLLEGE
DEPARTMENT OF MATHEMATICS
FINAL EXAMINATION
 $2\frac{1}{2}$ HOURS

Mathematics 141

Fall 2025

Instructions: Answer all questions. Show all work.

1. Refer to the graph of $f(x)$ shown here. Evaluate each of the following. If the result is $+\infty$, $-\infty$, or does not exist, so state.



- | | |
|------------------------------------|--|
| a) $\lim_{x \rightarrow 3^-} f(x)$ | g) $\lim_{x \rightarrow -\infty} f(x)$ |
| b) $\lim_{x \rightarrow 3} f(x)$ | h) $\lim_{x \rightarrow +\infty} f(x)$ |
| c) $\lim_{x \rightarrow -1} f(x)$ | i) $f(3)$ |
| d) $\lim_{x \rightarrow 1} f(x)$ | j) $f(2)$ |
| e) $\lim_{x \rightarrow -3} f(x)$ | k) $f(-3)$ |
| f) $\lim_{x \rightarrow 2} f(x)$ | l) $f(-1)$ |

2. Use analytical methods (not your calculator) to find each of the following limits. If the limit is $+\infty$, $-\infty$ or does not exist, explain why. You must show all your work for these examples, showing how you arrived at your answer.

- a) $\lim_{x \rightarrow -1^+} \frac{x^2 - x - 2}{x^2 + 2x + 1}$
- b) $\lim_{x \rightarrow 0} \frac{\tan 7x}{2 \sin 3x}$
- c) $\lim_{x \rightarrow 5} \frac{\frac{2x}{x+4} - \frac{10}{9}}{x-5}$
- d) $\lim_{x \rightarrow -\infty} \frac{4x^6 + 9x^7 - 10}{5x^6 - 3x^2 - 2x^7}$

3. Using your calculator construct a table to find $\lim_{x \rightarrow 0^+} \frac{x + 7^x - 1}{x + \sin x}$ correct to three decimal places. Include at least five appropriately-chosen x -values to justify your answer and copy the resulting table into your booklet.

4. a) Using only the definition of derivative, find $f'(x)$ if $f(x) = \sqrt{7x - 5}$.
 b) Find an equation of the tangent line to the curve $f(x)$ at the point where $x = 3$.

5. Show that the equation $\sin x - 4x = -15$ has at least one real root. Then use your calculator to estimate this root, accurate to three decimal places.

(continued on the back)

6. In each of the following, find $\frac{dy}{dx}$. (Algebraic simplification is not needed.)
- a) $y = \sqrt[3]{x^5} - \frac{7}{\sqrt[3]{x^5}} - \sin x + 3\pi^5 - 11x + 7$
- b) $y = (\tan(4x^2))\left(\frac{3}{x} - 15x\right)^{10}$
- c) $y = \frac{\sec^2 x}{10\sqrt[5]{x} - 7\pi}$
- d) $y = \cot(\sin(6x^4))$
- e) $y \cos x = 2x^3y^5$
7. Man A is 30 miles due north of man B. Man B starts walking due east at the rate of 3 miles per hour. At the same time, Man A starts bicycling due south at the rate of 11 miles per hour. How fast will the distance between Man A and Man B be changing 2 hours later? Interpret your answer.
8. A box with an open top is to be constructed from a 12 ft. x 12 ft. square piece of cardboard by cutting out a square from each of the four corners and bending up the sides. Find the largest volume that such a box can have and the dimensions of the box of largest volume. (Use calculus and show all necessary work.)
9. Let $f(x) = 4x^3 - x^4 - 15$. Using calculus and showing all necessary work,
- a) find the intervals of increase and intervals of decrease of f .
- b) find the local maximum and minimum values of f , if any.
- c) find the intervals where f is concave up and those where f is concave down.
- d) find any and all inflection points of f .
- e) Use the information found in parts a) through d) to sketch the graph of $y = f(x)$.

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