



1. If  $f(x) = x^2 - 1$ , find  $f(f(0))$ .

(A)  $-2$

(B)  $-1$

(C)  $0$

(D)  $1$

(E)  $2$

2. Suppose that  $f(x) = |x + 1|$  and the domain of  $f$  is  $(-\infty, -1]$ . Find  $f^{-1}(2)$ .

(A)  $-5$

(B)  $-4$

(C)  $-3$

(D)  $-2$

(E)  $-1$

**Record the correct answer to the following problems on the front page of this exam.**

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3. Which function below is equal to  $5^x$ ?

(A)  $e^{5x}$

(B)  $(\ln(x))^5$

(C)  $e^{5\ln(x)}$

(D)  $e^{x\ln(5)}$

(E)  $5^{\ln(x)}$

4. A bug crawls in a counter clockwise direction along a circle centered at the origin and of radius 3 units. The bug begins at the point  $(3, 0)$  and crawls for 9 minutes at a rate of 4 units per minute. Give the bug's location after 9 minutes.

(A)  $(\cos(4/3), \sin(4/3))$

(B)  $(3 \cos(12), 3 \sin(12))$

(C)  $(3 \cos(36), 3 \sin(36))$

(D)  $(3 \cos(4/3), 3 \sin(4/3))$

(E)  $(\cos(12), \sin(12))$

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5. Solve  $10^{2x+1} = 100$ .

- (A) 0
- (B)  $1/2$
- (C) 1
- (D)  $3/2$
- (E) 2

6. Find the value of the limit

$$\lim_{x \rightarrow 3} \frac{x - 3}{x^2 - 2x - 3}.$$

- (A)  $+\infty$
- (B)  $-\infty$
- (C) The limit does not exist and is not  $+\infty$  or  $-\infty$ .
- (D)  $1/4$
- (E)  $0/0$

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7. Suppose that

$$\lim_{x \rightarrow 3} (4f(x) - 3) = 1.$$

Find the value of

$$\lim_{x \rightarrow 3} f(x).$$

- (A) 0
- (B) 1
- (C) 2
- (D) 3
- (E) None of the above.

8. Suppose

$$f(x) = \begin{cases} \frac{\cos(2x) - 1}{x}, & x \neq 0 \\ c, & x = 0 \end{cases}$$

If  $f$  is continuous for all real numbers, what is the value of  $c$ ?

- (A) -2
- (B) -1
- (C) 0
- (D) 1
- (E) 2

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9. Suppose that  $f$  is a continuous function on the interval  $[0, 5]$  and we know that

$$f(0) = 1, f(1) = -1, f(2) = 1, f(3) = -1, f(4) = 1, \text{ and } f(5) = -1.$$

Which of the following statements will be true for any such  $f$ ?

- (A) There are at least five solutions of the equation  $f(x) = 0$  in the interval  $[0, 5]$ .
  - (B) There are at most five solutions of the equation  $f(x) = 0$  in the interval  $[0, 5]$ .
  - (C) There are exactly five solutions of the equation  $f(x) = 0$  in the interval  $[0, 5]$ .
  - (D) There are no solutions of the equation  $f(x) = 0$  in the interval  $[0, 5]$ .
  - (E) The equation  $f(x) = 1$  has exactly three solutions in the interval  $[0, 5]$ .
10. Suppose that the position of a particle at time  $t$  seconds is  $p(t) = t^3 - 4t^2$  meters to the right of the origin. Find the average velocity of the particle on the interval  $[1, 3]$ .
- (A)  $-6$  meters/second
  - (B)  $-3$  meters/second
  - (C)  $6$  meters/second
  - (D)  $3$  meters/second
  - (E)  $-18$  meters/second

**Free Response Questions: Show your work!**

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11. (a) Find the inverse function of the function given by

$$f(x) = \frac{4 + 3x}{3 + 2x}.$$

- (b) Give the domain and range of the function  $f^{-1}$  you find in part (a).

**Free Response Questions: Show your work!**

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12. Find the limits or state that the limit does not exist. In each case, justify your answer.

(Students who guess the answer based on a few values of the function will not receive full credit.)

(a)  $\lim_{t \rightarrow 0} \frac{t}{|t|}$

(b)  $\lim_{x \rightarrow 0} \frac{x^2 - 2x}{xe^x}$ .

**Free Response Questions: Show your work!**

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13. Using the graph of the function  $f$  below, complete the following. If the requested information does not exist, write DNE.

(a)  $\lim_{x \rightarrow -2^+} f(x) =$  \_\_\_\_\_

(b)  $\lim_{x \rightarrow -2^-} f(x) =$  \_\_\_\_\_

(c)  $\lim_{x \rightarrow -2} f(x) =$  \_\_\_\_\_

(d)  $f(-2) =$  \_\_\_\_\_

(e) Is  $f$  left-continuous at  $-2$ ? \_\_\_\_\_

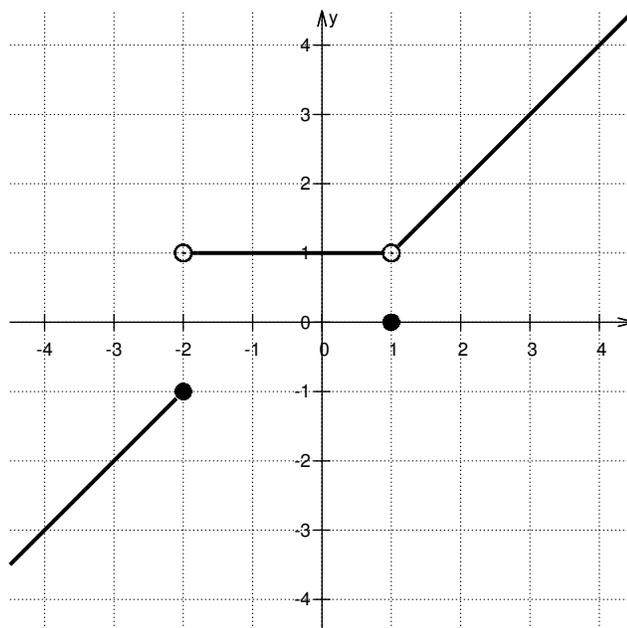
(f)  $\lim_{x \rightarrow 1^+} f(x) =$  \_\_\_\_\_

(g)  $\lim_{x \rightarrow 1^-} f(x) =$  \_\_\_\_\_

(h)  $\lim_{x \rightarrow 1} f(x) =$  \_\_\_\_\_

(i)  $f(1) =$  \_\_\_\_\_

(j) Is  $f$  left-continuous at  $1$ ? \_\_\_\_\_



**Free Response Questions: Show your work!**

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14. (a) State the squeeze theorem.  
(b) Use the squeeze theorem to find

$$\lim_{x \rightarrow 0} x^2 \cos(1/x).$$

**Free Response Questions: Show your work!**

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15. Consider the function  $f(x) = 1/(x + 3)$ .
- (a) Write an expression for the slope of the secant line that passes through the point  $(x, f(x))$  and  $(-1, f(-1))$ .
  - (b) Take the limit as  $x$  approaches  $-1$  of the expression you found in part (a) to find the slope of the tangent line to the graph of  $f$  at  $x = -1$ .
  - (c) Write the equation of the tangent line to the graph of  $f$  at  $x = -1$  in point-slope form.