



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

1. Find the equation of the line tangent to the function  $f(x) = 4x^4$  and parallel to the line given by the equation  $2x - y = 9$ .

- (A)  $y = 2x - 1$
- (B)  $y = 2x - \frac{3}{4}$
- (C)  $y = -2x + 1$
- (D)  $y = 2x + \frac{1}{2}$
- (E) None of the above

2. Find the linearization  $L(x)$  of the function  $f(x) = 1 + \cos(x)$  at  $a = \frac{\pi}{4}$ .

- (A)  $L(x) = (1 + \frac{\sqrt{2}}{2}) - \frac{\sqrt{2}}{2}(x - \frac{\pi}{4})$
- (B)  $L(x) = (1 + \frac{\sqrt{2}}{2}) + \frac{\sqrt{2}}{2}(x - \frac{\pi}{4})$
- (C)  $L(x) = (1 + \frac{\sqrt{2}}{2}) - \frac{\sqrt{2}}{2}(x + \frac{\pi}{4})$
- (D)  $L(x) = (1 + \frac{\sqrt{2}}{2}) + \frac{\sqrt{2}}{2}(x + \frac{\pi}{4})$
- (E)  $L(x) = (1 - \frac{\sqrt{2}}{2}) - \frac{\sqrt{2}}{2}(x - \frac{\pi}{4})$

3. Suppose  $f(x) = x^2[g(x)]^3$ ,  $g(4) = 2$ , and  $g'(4) = 3$ . Find  $f'(4)$ .

- (A) 208
- (B) 310
- (C) 425
- (D) 640
- (E) 696

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4. Find  $\lim_{x \rightarrow 0} \frac{\tan(3x)}{5x}$ .

- (A) 0
- (B)  $\frac{3}{25}$
- (C)  $\frac{3}{5}$
- (D)  $\frac{5}{3}$
- (E)  $\frac{9}{25}$

5. Suppose that a function  $f$  is defined by

$$f(x) = \begin{cases} \sqrt{x}, & 0 < x < 1 \\ c, & x = 1 \\ x^2 + 1, & x > 1 \end{cases}$$

For what choice of  $c$  is  $f$  continuous at  $x = 1$ ?

- (A) 1
- (B) 2
- (C) 3
- (D) 4
- (E) None of the above

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6. Evaluate  $\int_{-2}^1 3 + 2|x| dx$ .

- (A) 10
- (B) 11
- (C) 12
- (D) 13
- (E) 14

7. Suppose  $G(x) = \int_1^{x^3} te^t dt$ . Find  $G'(2)$ .

- (A)  $52e^4$
- (B)  $96e^4$
- (C)  $52e^8$
- (D)  $96e^8$
- (E) None of the above

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8. The doubling time of a population of bacteria is 10 hours. Suppose the initial population is 100. What is the population after 25 hours?

- (A)  $200\sqrt{2}$
- (B)  $400\sqrt{2}$
- (C) 450
- (D) 600
- (E) 650

9. Find  $\int \frac{[\ln(x)]^2}{x} dx$

- (A)  $\frac{1}{3}[\ln(x)]^3 + C$
- (B)  $x[\ln(x)]^3 + C$
- (C)  $\frac{[\ln(x)]^3}{x} + C$
- (D)  $\frac{[\ln(x)]^3}{x^2} + C$
- (E)  $\frac{2}{3} \frac{[\ln(x)]^3}{x^2} + C$

10. A right cylinder with radius 2 and height 20, both measured in inches, is being filled with water. The water pours in at the rate of 10 cubic inches per second. Find the rate at which the level of the water is rising in the tank.

- (A)  $\frac{1}{5}$
- (B) 1
- (C) 5
- (D)  $\frac{5}{\pi}$
- (E)  $\frac{5}{2\pi}$

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

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11. Consider the functions  $f(x) = \sqrt{x}$  and  $g(x) = x^2$ .

(a) Sketch and label the graphs of  $f$  and  $g$ .

(b) Find the intersection points of  $f$  and  $g$ .

(c) Find the area of the region bounded by  $f(x)$  and  $g(x)$  between the vertical lines  $x = 0$  and  $x = 2$ .

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

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12. The base of a rectangle is on the  $x$ -axis and the other two corners are above the  $x$ -axis lying on the curve given by  $y = 6 - x^2$ .

(a) Sketch the curve  $y = 6 - x^2$  and this rectangle.

(b) Express the area of the rectangle as a function of a single variable.

(c) Find the dimensions and area of the largest such rectangle. Justify your answer.

Free Response Questions: Show your work!

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13. Evaluate

(a)  $\int_0^1 \frac{e^{2x}}{1 + e^{2x}} dx$

(b)  $\int x\sqrt{x+1} dx$

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

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14. Assume that the derivative of a function  $f(x)$  satisfies  $f'(x) = xe^{-x}$ .

(a) Find the intervals over which  $f$  is increasing, the intervals where  $f$  is decreasing, and find all the local minima and maxima of  $f$ .

(b) Find the intervals over which  $f$  is concave down, the intervals over which  $f$  is concave up, and find all points of inflection of  $f$ .

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

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15. For  $t \geq 0$ , the velocity of a particle moving along the real line is given by  $v(t) = t^2 - 2t$  where  $t$  is measured in seconds.

(a) Find the time intervals over which the velocity of the particle is positive and the time intervals over which the velocity is negative.

(b) Find the total distance traveled over the first 4 seconds.