PART I - MULTIPLE CHOICE

The use of a calculator, laptop, or computer is prohibited. Mark the correct choice on your ScanTron using a No. 2 pencil. For your own records, also record your choices on your exam! Be sure to write your name, section and version letter of the exam on the ScanTron form. Each problem is worth 3 points.

1. Given \( f(x) = \frac{x - 4}{3x + 5} \), what is \( f'(0) \)?

   (a) \( \frac{1}{3} \) \hspace{1cm} (b) \( \frac{-4}{5} \) \hspace{1cm} (c) \( \frac{17}{25} \) \hspace{1cm} (d) None of these \hspace{1cm} (e) \( \frac{-17}{16} \)

2. A particle moves according to the equation \( s = t^2 - 8t - 9 \), where \( t \) is measured in seconds and \( s \) is in feet. When is the particle at rest?

   (a) 4 seconds \hspace{1cm} (b) 9 seconds and -1 seconds \hspace{1cm} (c) 9 seconds

   (d) 8 seconds \hspace{1cm} (e) None of these

3. Evaluate \( \lim_{x \to 0} \frac{\sin(7x)}{x \cos(8x)} \).

   (a) 7 \hspace{1cm} (b) None of these \hspace{1cm} (c) \( \frac{8}{7} \) \hspace{1cm} (d) \( \frac{7}{8} \) \hspace{1cm} (e) 8

4. Which of the following is the derivative of \( f(x) = \csc x \)?

   (a) None of these \hspace{1cm} (b) \( -\sec x \) \hspace{1cm} (c) \( \sec x \) \hspace{1cm} (d) \( -\cot^2 x \) \hspace{1cm} (e) \( -\csc x \cot x \)

5. Evaluate \( \lim_{x \to 1} e^{1/(x-1)} \).

   (a) \( e \) \hspace{1cm} (b) 1 \hspace{1cm} (c) \( \infty \) \hspace{1cm} (d) 0 \hspace{1cm} (e) None of these
6. Given \( r(t) = (1 + t^2)i + t^3j \), find a tangent vector of unit length at the point where \( t = 1 \).

(a) \( 2i + j \)
(b) \( \frac{2}{\sqrt{5}}i + \frac{1}{\sqrt{5}}j \)
(c) \( 2i + 5j \)
(d) None of these
(e) \( \frac{2}{\sqrt{29}}i + \frac{5}{\sqrt{29}}j \)

7. For which value of \( r \) does \( y = e^{rx} \) satisfy the differential equation \( y' - 6y = 0 \) ?

(a) \( r = -6 \)
(b) \( r = 6 \)
(c) \( r = -5 \)
(d) No value of \( r \) exists
(e) None of these

8. Find the point(s) on the curve \( x = t^2 + 4t, y = t^2 + 2t \) where the tangent line is vertical.

(a) \((-3, -1)\)
(b) \((0, 0)\) and \((0, 8)\)
(c) \((0, 0)\) and \((-4, 0)\)
(d) None of these
(e) \((-4, 0)\)

9. Find the point(s) on the curve \( x = t^2 + 4t, y = t^2 + 2t \) where the tangent line is horizontal.

(a) \((0, 0)\) and \((0, 8)\)
(b) \((-3, -1)\)
(c) \((-4, 0)\)
(d) \((0, 0)\) and \((-4, 0)\)
(e) None of these

10. Find the slope of the line tangent to the curve \( x^2 + y^2 = 13 \) at the point \((3, -2)\).

(a) None of these
(b) \(\frac{3}{2}\)
(c) \(-\frac{3}{2}\)
(d) \(-\frac{2}{3}\)
(e) \(\frac{2}{3}\)

11. Which of these is the equation of the line tangent to the curve parametrized by \( x = 5t - t^3, y = t^2 - 2t \) at the point corresponding to \( t = 0 \).

(a) \( y = -\frac{5}{2}x \)
(b) None of these
(c) \( y = -x \)
(d) \( y = 0 \)
(e) \( y = -\frac{2}{5}x \)
12. A cubic block of ice (which remains in the shape of a cube) is melting so that its volume is decreasing at a rate of 4 cm$^3$/min. How fast is the length of a side changing (in cm/min) when the sides are 10 cm?

(a) $-\frac{1}{1200}$ (b) None of these (c) $\frac{4}{300}$ (d) $\frac{1}{1200}$ (e) $-\frac{4}{300}$

13. Find $L(x)$, the linear approximation to $f(x) = e^{3x}$ at $a = 0$.

(a) $L(x) = 1 + 3xe^{3x}$ (b) $L(x) = 1 + 3x$ (c) $L(x) = 1 + \frac{3}{e}x$ (d) $L(x) = 1 - 3x$ (e) None of these

14. Which of the following is a sketch of the curve whose vector equation is $\mathbf{r}(t) = (3 + \cos t)i + (2 - \sin t)j$, indicating the direction in which $t$ increases?

(a) (b) (c) (d) (e) None of these

15. The radius of a circle is measured to be 1 meter with a possible error of ±0.03 m. Use differentials or linear approximation to estimate the maximum possible error in the area of the circle.

(a) None of these (b) ±0.03$\pi$ (c) ±0.06$\pi$ (d) ±0.09$\pi$ (e) ±0.12$\pi$

16. Given the table of values below, if $u(x) = f(x) \cdot g(x)$, what is $u'(1)$?

<table>
<thead>
<tr>
<th>$x$</th>
<th>$f(x)$</th>
<th>$f'(x)$</th>
<th>$g(x)$</th>
<th>$g'(x)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>-2</td>
<td>2</td>
<td>-2</td>
</tr>
<tr>
<td>2</td>
<td>-3</td>
<td>2</td>
<td>-1</td>
<td>-5</td>
</tr>
</tbody>
</table>

(a) -10 (b) 4 (c) 6 (d) 10 (e) None of these

17. Given the table of values above, if $v(x) = f(g(x))$, what is $v'(1)$?

(a) -3 (b) -4 (c) Cannot be determined (d) None of these (e) 6
PART II WORK OUT

Directions: Present your solutions in the space provided. Show all your work neatly and concisely and Box your final answer. You will be graded not merely on the final answer, but also on the quality and correctness of the work leading up to it.

18. Find the indicated derivatives (Do NOT simplify):

(a) (4 pts) $f'(x)$ if $f(x) = \frac{1 - 6x}{\cos x}$.

(b) (4 pts) $\frac{dy}{dx}$ if $y = e^x \cot^2 x$.

(c) (6 pts) The second derivative of $f(x) = e^{-x^5}$.
(d) (4 pts) The 77th derivative of \( g(x) = \sin(2x) \).

19. (9 pts) Given the equation \( 2x^2y - 3y^2 = -11 \):
   
   (a) Find \( \frac{dy}{dx} \).

   (b) Find the equation of the line tangent to the curve at the point \( (2, -1) \).
20. (7 pts) Cyclist A starts at point $P$ and rides west at 15 mph. At the same time, cyclist B starts 10 miles north of point $P$ and rides north at 15 mph. How fast is the distance between them changing after 2 hours?

21. (7 points) Find the equation of the line tangent to the curve $y = \sqrt{x^7 + (2x - 1)^5}$ at the point where $x = 1$. 
22. (8 pts) The position of an object is given by \( \mathbf{r}(t) = (3 \sin t)\mathbf{i} + (t \cos t)\mathbf{j} \). Find the velocity, speed, and acceleration of the object when \( t = \pi \).

23. (4 point BONUS: Appropriate work must be shown to receive any credit)

Evaluate \( \lim_{x \to 0} \frac{\cos 1 \cos x - \sin 1 \sin x - \cos 1}{x} \).
MATH 151 Exam II

Print name (LAST, First):


SECTION #: ______