DIRECTIONS:

1. The use of a calculator, laptop or cell phone is prohibited.

2. TURN OFF cell phones and put them away. If a cell phone is seen during the exam, your exam will be collected and you will receive a zero.

3. In Part 1 (Problems 1-15), mark the correct choice on your ScanTron using a No. 2 pencil. The ScanTron will not be returned, therefore for your own records, also record your choices on your exam! Each problem is worth 4 points.

4. In Part 2 (Problems 16-20), present your solutions in the space provided. Show all your work neatly and concisely and clearly indicate 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.

5. Be sure to write your name, section number and version letter of the exam on the ScanTron form.

THE AGGIE CODE OF HONOR

“An Aggie does not lie, cheat or steal, or tolerate those who do.”

Signature: ________________________________

DO NOT WRITE BELOW!

<table>
<thead>
<tr>
<th>Question</th>
<th>Points Awarded</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-15</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>7</td>
<td></td>
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<tr>
<td>19</td>
<td>12</td>
<td></td>
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<tr>
<td>20</td>
<td>7</td>
<td></td>
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<tr>
<td>Total</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>
PART I: Multiple Choice. 4 points each.

1. Given $H(x) = xf(p(x))$, find $H'(3)$ if it is known that $p(3) = 7$, $f'(7) = 2$, $f(7) = 4$, $f'(3) = 5$ and $p'(3) = -1$.
   (a) $-2$
   (b) 10
   (c) $-6$
   (d) $-38$
   (e) 12

2. $\lim_{x \to 2} \frac{\sin(x - 2)}{x^2 + 2x - 8} =$
   (a) 0
   (b) $\frac{1}{9}$
   (c) 1
   (d) $\frac{1}{6}$
   (e) The limit does not exist.

3. $\lim_{x \to 0^-} \frac{3}{1 + e^{1/x}} =$
   (a) $-\infty$
   (b) $\infty$
   (c) 0
   (d) 1
   (e) 3
4. Find a tangent vector for \( \mathbf{r}(t) = \langle t \cos(2t), e^{5t} \rangle \) at \( t = \pi \).
   (a) \( \langle -1, 5e^{5\pi} \rangle \)
   (b) \( \langle 1, e^{5\pi} \rangle \)
   (c) \( \langle -2\pi, 5e^{5\pi} \rangle \)
   (d) \( \langle 1, 5e^{5\pi} \rangle \)
   (e) \( \langle \pi, e^{5\pi} \rangle \)

5. Find \( f''(1) \) if \( f(x) = (3x - 1)^5 \)
   (a) 960
   (b) 1440
   (c) 480
   (d) 240
   (e) 160

6. What is the slope of the parametric curve \( x = t^2 + t + 2 \), \( y = 4 - 7t \) at the point \( (4, -3) \)?
   (a) \( -1 \)
   (b) \( \frac{7}{3} \)
   (c) \( \frac{7}{3} \)
   (d) \( \frac{3}{7} \)
   (e) \( -\frac{3}{7} \)
7. Find all point(s) on the curve defined by the parametric equations \( x = t^3 - 3t - 1 \) and \( y = t^3 - 12t + 3 \) where the tangent line is vertical.
   (a) \((-3, -8)\) and \((1, 14)\)
   (b) \((1, -1)\)
   (c) \((-3, -8)\)
   (d) \((1, -13)\) and \((-3, 19)\)
   (e) \((1, -13)\)

8. Suppose an object is moving according to the position function \( s(t) = \cos t + \frac{t^2}{4} \), where \( t \) is measured in minutes and \( s(t) \) in feet. At what time(s) is the acceleration equal to zero for \( 0 \leq t \leq 2\pi \)?
   (a) \( t = \frac{\pi}{3} \) and \( t = \frac{2\pi}{3} \)
   (b) \( t = \frac{\pi}{6} \) and \( t = \frac{11\pi}{6} \)
   (c) \( t = \frac{\pi}{6} \) and \( t = \frac{5\pi}{6} \)
   (d) \( t = \frac{\pi}{3} \) and \( t = \frac{4\pi}{3} \)
   (e) \( t = \frac{\pi}{3} \) and \( t = \frac{5\pi}{3} \)

9. Find the slope of the tangent line to the curve \( x^3 - 3xy + y^3 = 3 \) at the point \((2, 1)\).
   (a) \(3\)
   (b) \(2\)
   (c) \(-3\)
   (d) \(-1\)
   (e) \(-2\)
10. At what point on the curve \( f(x) = 36\sqrt{x} \) is the tangent line parallel to the line \( 9x - y + 2 = 0 \)?

(a) (16, 144)
(b) \( \left( \frac{1}{4}, 18 \right) \)
(c) (4, 38)
(d) \( \left( \frac{1}{16}, 9 \right) \)
(e) (4, 72)

11. Find the quadratic approximation for \( f(x) = xe^{3x} \) at \( x = 0 \).

(a) \( x + 6x^2 \)
(b) \( 1 + x + x^2 \)
(c) \( x + 3x^2 \)
(d) \( 1 + x + \frac{e^2}{2} \)
(e) \( x + 2x^2 \)

12. Find \( f^{(99)}(x) \), that is the ninety-ninth derivative of \( f(x) \), for \( f(x) = \frac{1}{x} \).

(a) \( -\frac{99!}{x^{99}} \)
(b) \( \frac{100!}{x^{99}} \)
(c) \( -\frac{99!}{x^{100}} \)
(d) \( -\frac{100!}{x^{99}} \)
(e) \( \frac{99!}{x^{100}} \)
13. Given \( f(x) = \frac{x^2}{h(x)} \), find \( f'(2) \) if it is known that \( h(2) = -4 \) and \( h'(2) = 3 \).

(a) \( -\frac{28}{9} \)

(b) \( \frac{1}{4} \)

(c) \( -\frac{7}{2} \)

(d) \( -\frac{7}{4} \)

(e) \( \frac{7}{4} \)

14. An object is moving along a straight path. The position of the object at time \( t \) is given by \( s(t) = 2t^3 - 9t^2 + 12t + 1 \), where \( t \) is measured in seconds and \( s(t) \) is measured in feet. Find the total distance traveled in the first 2 seconds.

(a) 4 feet

(b) 3 feet

(c) 8 feet

(d) 5 feet

(e) 6 feet

15. Sketch the graph of \((2 + \cos t, 4 + \sin t)\) and indicate the direction of the curve as \( t \) increases.
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.

16. (8 pts) A trough 8 feet long, 3 feet high and 2 feet across the top is being filled with water at a rate $\frac{1}{20}$ cubic feet per minute. At what rate is the water level rising when the height of the water is 2 feet?
17. (6 pts) Use an appropriate linear (tangent) approximation to estimate $\sqrt{27.01}$.

18. (7 pts) The horizontal line through the point (3, 1) is tangent to the parabola $y = x^2 + 1$. We see from the figure below that there is a second line tangent to the parabola at $(a, a^2 + 1)$ that also passes through the point (3, 1). Find the value of $a$. 
19. Find $f'(x)$. Do not simplify.
   (a) (6 pts) $f(x) = x \cos^7(\sin(6x))$

   (b) (6 pts) $f(x) = \frac{(x - 3)^2}{e^{x^2 + 5x}}$

20. (7 pts) Find $\frac{dy}{dx}$ if $\tan(x^2) + \sin y = 6x + 8y^2 + 4$