1. **(6 points)** Use the given graph of $f$ to state the value of each quantity, if it exists. (If an answer does not exist, enter DNE).

(a) $\lim_{x \to 2^-} f(x)$

(b) $\lim_{x \to 2^+} f(x)$

(c) $\lim_{x \to 2} f(x)$

(d) $f(2)$

(e) $\lim_{x \to 4} f(x)$

(f) $f(4)$

2. **(4 points)** A table of values for $f$, $g$, $f'$ and $g'$ is given.

<table>
<thead>
<tr>
<th>$x$</th>
<th>$f(x)$</th>
<th>$g(x)$</th>
<th>$f'(x)$</th>
<th>$g'(x)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>8</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>2</td>
<td>3</td>
<td>7</td>
</tr>
</tbody>
</table>

(a) If $A(x) = 3f(x) + 2g(x)$, find $A'(2)$.

(b) If $H(x) = g(f(x))$, find $H'(2)$.

(c) If $P(x) = f(x)g(x)$, find $P'(1)$.

(d) If $Q(x) = \frac{f(x)}{g(x)}$, find $Q'(1)$. 
3. (6 points) The vase pictured is obtained by rotating a curve:

The vase is empty at time \( t = 0 \) and is being filled at a constant rate with water. Let \( V \) be the volume of water in the vase, \( h \) the height of the water in the vase and \( t \) the time. Indicate which graph best fits the indicated functions.

(a) \( V(h) \)  
(b) \( \frac{dV}{dh} \)  
(c) \( V(t) \)  
(d) \( \frac{dV}{dt} \)  
(e) \( h(t) \)  
(f) \( \frac{dh}{dt} \)

A B C  
D E F  
G H I
4. (16 points, 2/2/3/3/3/3)

Compute the following derivatives using any methods we have covered in class.

(a) \(7x^2 - 5x^{\frac{1}{3}}\)
(b) \(\sqrt{x} e^x\)
(c) \(\frac{\sin x}{1 - \cos x}\)
(d) \((1 + \tan x)^x\)
(e) \(e^{x \sec x}\)
(f) \(\frac{1}{\sqrt{1 + \sin 5x}}\)

5. (10 points)

Use the definition of the derivative to show

if \(f(x) = 2x^2 - 3x + 1\) then \(f'(x) = 4x - 3\)

6. (8 points)

Find an equation of the tangent line to the curve at the given point.

\(y = x + e^{(x^2+1)}, \quad (1, 1 + e^2)\)

7. (10 points) Find the horizontal and vertical asymptotes of the curve.

(a) \(y = \frac{x^2 - x - 2}{x^2 - 2x - 3}\)
(b) \(y = \frac{e^{x^2}}{e^{x^2} - e}\)

8. (8 points) Show that there is a point on the graph of \(f(x) = x^2e^x\) where the tangent line is parallel to the line \(y = 3x - 2\).

9. (8 points) Show that the function

\[ f(x) = \begin{cases} 
  x^2 \cos \left( \frac{1}{x} \right) & x \neq 0 \\
  0 & x = 0 
\end{cases} \]
is differentiable at 0. Hint: You need to use the definition of the derivative.