1. (1 pt each, 20 pts total) Place the letter corresponding to the correct answer in the box next to each question. Each correct answer is worth 2 points.

(i) □ Suppose \( a < 0 \) and \( b > 0 \). Then which of the following must be true?
   (a) \( ab > 0 \) (b) \( a - b > 0 \) (c) \( b - a > 0 \) (d) \( b^2 - a^2 > 0 \) (e) \( a^2 + b^2 < 0 \) (f) none of these.

(ii) □ Suppose \( f \) is a linear function such that \( f(1) = -1 \) and \( f(3) = 2 \). Then \( f(4) = ? \)
   (a) \( 3 \) (b) \( 3 \frac{1}{3} \) (c) \( 3 \frac{2}{3} \) (d) \( 3 \frac{1}{2} \) (e) \( 3 \frac{3}{4} \) (f) none of these.

(iii) □ Which interval is the solution of \( |x - 2| < 3 \)?
   (a) \( (0, 3) \) (b) \( [-1, 3] \) (c) \( (-2, 5) \) (d) \( [0, 5] \) (e) \( (-1, 5) \) (f) none of these.

(iv) □ Suppose \( f \) and \( g \) are given by the following tables. What is \( f(g(2)) \)?

<table>
<thead>
<tr>
<th>( x )</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f(x) )</td>
<td>0</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>( g(x) )</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

(a) 0 (b) 1 (c) 2 (d) 3 (e) 4 (f) it is undefined.

(v) □ What is \( \lim_{x \to 2} \frac{x^2 - 4}{x - 2} \)?
   (a) 1 (b) 2 (c) 3 (d) 4 (e) \( \infty \) (f) none of these.

(vi) □ What is the natural domain of \( \sqrt{x^2 - \frac{1}{x}} \)?
   (a) \( x > 0 \) (b) \( -1 < x < 1 \) (c) \( x > 1 \) (d) \( x \geq 1 \) and \( x < 0 \) (e) \( -1 < x < 0 \) and \( 0 < x < 1 \) (f) none of these.

(vii) □ Suppose that for all \( C > 0 \) there is a \( \epsilon > 0 \) so that \( |x| < \epsilon \) implies \( f(x) > C \). Then
   (a) \( \lim_{x \to 0} f(x) = +\infty \) (b) \( \lim_{x \to +\infty} f(x) = 0 \) (c) \( \lim_{x \to +\infty} f(x) = 1 \) (d) \( \lim_{x \to +\infty} f(x) = +\infty \) (e) \( \lim_{x \to 0} f(x) = 0 \). (f) none of these.

(viii) □ The derivative of \( g \) at \( x \) is defined to be
   (a) \( \lim_{h \to 0} \frac{g(x+h) - g(x)}{h} \) (b) \( \lim_{h \to 0} \frac{g(h) - g(x)}{x+h} \) (c) \( \lim_{h \to 0} \frac{g(x+h) - g(x)}{h} \) (d) \( \lim_{h \to 0} \frac{g(x+h) - g(x)}{h} \) (e) \( \lim_{h \to 0} \frac{g(x+h) + g(x)}{h} \). (f) none of these.
(ix) □ Which of the following is true?
(a) If \( f \) has a limit at \( x_0 \) it is continuous at \( x_0 \).  
(b) If the left and right limits exist at \( x_0 \) then the limit exists at \( x_0 \).  
(c) If \( f \) is continuous at \( x_0 \) it has a limit at \( x_0 \).  
(d) If \( f \) is continuous at \( x_0 \) then it is differentiable at \( x_0 \).  
(e) If \( f \) is continuous at \( x_0 \) it is continuous on an interval around \( x_0 \).  
(f) none of these.

(x) □ Suppose \( f \) is continuous on the real line and \( f(0) = 0 \) and \( f(10) = 2 \). Then which of the following must be true?
(a) \( f \) attains a maximum which is \( >2 \).  
(b) \( f \) takes the value 1 somewhere between 0 and 10.  
(c) \( f \) is increasing between 0 and 10.  
(d) \( f \) takes its maximum value between 0 and 10.  
(e) \( f \) is never negative.  
(f) none of these.

(xi) □ The derivative of \( f(x) = x^2 + x^3 \) at \( x = 2 \) is (a) 12 (b) 13 (c) 14 (d) 15 (e) 16 (f) none of these.

(xii) □ A car drives 30 miles at 60 mph and then another 50 miles at 50 mph. What is the average speed for the entire trip?
(a) 50 mph (b) 52\(\frac{1}{2} \) mph (c) 53\(\frac{1}{3} \) mph (d) 55 mph (e) 57 mph (f) none of these.

(xiii) □ List every point \( a \) between 0 and 6 in the graph on the left below where \( \lim_{x \to a} f(x) \) does not exist (standard definition of finite limit)
(a) 1, 2, 3, 5 (b) 1, 3, 5 (c) 3, 5 (d) 2, 5 (e) 1, 5 (f) none of these.

(xiv) □ Consider the graph on the left below. At what points does the function fail to be continuous? (a) 1, 2, 3, 5 (b) 1, 3, 5 (c) 3, 5 (d) 2, 5 (e) 1, 5 (f) none of these.

(xv) □ What is the relationship between \( f \) and \( g \) in the graph on right above?
(a) \( g(x) = f(x - 1) + 2 \) (b) \( g(x) = f(x - 2) + 1 \) (c) \( g(x) = f(x + 2) - 1 \) (d) \( g(x) = f(x + 1) - 2 \) (e) \( g(x) = f(x - 2) - 1 \) (f) none of these.

(xvi) □ Let \( f(x) = |x^2 - 1| \). Then
(a) \( f \) is differentiable everywhere (b) \( f \) is not differentiable at \( x = 0 \) (c) \( f \) is not differentiable at \( x = -1 \) and \( x = 1 \) (d) \( f \) is not differentiable anywhere (e) \( f \) is not differentiable between \(-1\) and \(1 \) (f) none of these.
(xvii) The derivative of \((xh(x))^2\) is
- \((a) 1 + 2xh'(x)\)
- \((b) 2xh'(x)(1 + h'(x))\)
- \((c) 2xh(x)(h(x) + xh'(x))\)
- \((d) h(x) + xh'(x)\)
- \((e) 2xh(x)(1 + xh'(x))\)
- \((f)\) none of these.

(xviii) A dynamite blast blows a heavy rock straight up with an initial velocity of 160ft/sec. How high does the rock go (in feet)?
- \((a) 100\)
- \((b) 200\)
- \((c) 300\)
- \((d) 400\)
- \((e) 500\)
- \((f)\) none of these.

(xix) On planet X a ball dropped from rest falls 36 meters in 2 seconds. The acceleration due to gravity is
- \((a) 36m/sec^2\)
- \((b) 18m/sec^2\)
- \((c) 6m/sec^2\)
- \((d) \sqrt{18} m/sec^2\)
- \((e) 3m/sec^2\)
- \((f)\) none of these.

(xx) Which of the following satisfies \(f'(0) < 0\)?
- \((a)\)
- \((b)\)
- \((c)\)
- \((d)\)
- \((e)\)
- \((f)\)

2. (2 pts each, 10 pts total) For each of the following functions, find the derivative function.

(i) \(f(x) = x^6 + x^{2/3} + x^{-2}\),
\[
\frac{df}{dx} =
\]

(ii) \(f(x) = x^3 \cos(x)\),
\[
\frac{df}{dx} =
\]
(iii) \( f(x) = \sin(x^2 + \tan(x)) \), \[ \frac{df}{dx} f(x) = \]

(iv) \( f(x) = \frac{x^2 - 1}{x - 1} \), \[ \frac{df}{dx} f(x) = \]

(v) \( f(x) = A \cos(Bx + C) \), \[ \frac{df}{dx} f(x) = \]
3. (5 pts) Compute the derivative of $f(x) = 1/x$ at $x = a \neq 0$ using only the limit definition of derivative.

4. (5 pts) Suppose that the functions $f$ and $g$ are defined on an open interval $I$ containing the point $x_0$, that $f$ is differentiable at $x_0$, that $f(x_0) = 0$ and that $g$ is is continuous at $x_0$. Show the product $fg$ is differentiable at $x_0$. 