Do not remove this answer page — you will turn in the entire exam. You have two hours to do this exam. No books or notes may be used. You may use a graphing calculator during the exam, but NO calculator with a Computer Algebra System (CAS) or a QWERTY keyboard is permitted. Absolutely no cell phone use during the exam is allowed.

The exam consists of multiple choice questions. Record your answers on this page. For each multiple choice question, you will need to fill in the box corresponding to the correct answer. For example, if (a) is correct, you must write

[ ] b [ ] c [ ] d [ ] e

Do not circle answers on this page, but please circle the letter of each correct response in the body of the exam. It is your responsibility to make it CLEAR which response has been chosen. You will not get credit unless the correct answer has been marked on both this page and in the body of the exam.

GOOD LUCK!

1. a [ ] c [ ] d [ ] e
2. a b [ ] c d [ ]
3. a b [ ] c d [ ]
4. a b [ ] c [ ] e
5. a b [ ] c [ ] e
6. a b [ ] d [ ] e
7. a b [ ] c [ ] e
8. a b [ ] c [ ] e
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10. a b [ ] c [ ] e
11. [ ] b [ ] c [ ] d [ ] e
12. [ ] b [ ] c [ ] d [ ] e
13. [ ] b [ ] c [ ] d [ ] e
14. a b [ ] c [ ] d [ ]
15. [ ] b [ ] c [ ] d [ ] e
16. a [ ] c [ ] d [ ] e
17. [ ] b [ ] c [ ] d [ ] e
18. a b [ ] c [ ] e
19. a [ ] c [ ] d [ ] e
20. a b [ ] d [ ] e

For grading use:

<table>
<thead>
<tr>
<th>Number Correct</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>(out of 20 problems)</td>
<td>(out of 100 points)</td>
</tr>
</tbody>
</table>
Please make sure to list the correct section number on the front page of your exam. In case you forgot your section number, consult the following table. If you are enrolled in a lecture with recitation, then your time and location is based on your recitation, not your lecture.

<table>
<thead>
<tr>
<th>Section #</th>
<th>Instructor</th>
<th>Lectures</th>
</tr>
</thead>
<tbody>
<tr>
<td>001</td>
<td>Koester/Hamilton</td>
<td>T 8:00 - 9:15 am, CP 243</td>
</tr>
<tr>
<td>002</td>
<td>Koester/Hamilton</td>
<td>R 8:00 - 9:15 am, CP 243</td>
</tr>
<tr>
<td>003</td>
<td>Koester/Hamilton</td>
<td>T 9:30 - 10:45 am, MMRB 243</td>
</tr>
<tr>
<td>004</td>
<td>Koester/May</td>
<td>R 9:30 - 10:45 am, CB 342</td>
</tr>
<tr>
<td>005</td>
<td>Koester/May</td>
<td>T 11:00 - 12:15 pm, CP 220</td>
</tr>
<tr>
<td>006</td>
<td>Koester/May</td>
<td>R 11:30 - 12:15 pm, CP 220</td>
</tr>
<tr>
<td>007</td>
<td>Koester/Kyriopoulos</td>
<td>T 9:30 - 10:45 am, CP 367</td>
</tr>
<tr>
<td>008</td>
<td>Koester/Kyriopoulos</td>
<td>R 9:30 - 10:45 am, DH 323</td>
</tr>
<tr>
<td>009</td>
<td>Koester/Kyriopoulos</td>
<td>T 11:00 - 12:15 pm, FB 307A</td>
</tr>
<tr>
<td>010</td>
<td>Koester/Robinson</td>
<td>R 11:00 - 12:15 pm, CP 345</td>
</tr>
<tr>
<td>011</td>
<td>Koester/Robinson</td>
<td>T 12:30 - 1:45pm, CB 219</td>
</tr>
<tr>
<td>012</td>
<td>Koester/Robinson</td>
<td>R 12:30 - 1:45pm, CB 219</td>
</tr>
<tr>
<td>013</td>
<td>Shaw/Taylor</td>
<td>T 11:00 - 12:15 pm, CB 345</td>
</tr>
<tr>
<td>014</td>
<td>Shaw/Taylor</td>
<td>R 11:00 - 12:15 pm, MMRB 243</td>
</tr>
<tr>
<td>015</td>
<td>Shaw/Taylor</td>
<td>T 12:30 - 1:45 pm, Nurs 201</td>
</tr>
<tr>
<td>016</td>
<td>Shaw/Tarr</td>
<td>R 12:30 - 1:45 pm, Nurs 502A</td>
</tr>
<tr>
<td>017</td>
<td>Shaw/Tarr</td>
<td>T 2:00 - 3:15 pm, CB 233</td>
</tr>
<tr>
<td>018</td>
<td>Shaw/Tarr</td>
<td>R 2:00 - 3:15 pm, CB 245</td>
</tr>
<tr>
<td>019</td>
<td>Shaw/Ozbek</td>
<td>T 3:30 - 4:45 pm, CP 208</td>
</tr>
<tr>
<td>020</td>
<td>Shaw/Ozbek</td>
<td>R 3:30 - 4:45 pm, CP 208</td>
</tr>
<tr>
<td>021</td>
<td>Shaw/Ozbek</td>
<td>T 2:00 - 3:15 pm, FB B2</td>
</tr>
<tr>
<td>022</td>
<td>Shaw/Zhi</td>
<td>R 2:00 - 3:15 pm, CP 233</td>
</tr>
<tr>
<td>023</td>
<td>Shaw/Zhi</td>
<td>T 9:30 - 10:45 am, CP 211</td>
</tr>
<tr>
<td>024</td>
<td>Shaw/Zhi</td>
<td>R 9:30 - 10:45 am, CB 341</td>
</tr>
<tr>
<td>025</td>
<td>Beth Kelly</td>
<td>MWF 12:00 - 12:50 pm, CP 153</td>
</tr>
<tr>
<td>026</td>
<td>John Maki</td>
<td>MWF 2:00 - 2:50 pm, KAS 213</td>
</tr>
</tbody>
</table>

You may use the following formula for the derivative of a quadratic function.

If \( p(x) = Ax^2 + Bx + C \), then \( p'(x) = 2Ax + B \).
1. Find the slope of the line in the graph shown below.

Possibilities:

(a) \( \frac{4}{5} \)
(b) \( \frac{5}{4} \)
(c) \( \frac{-5}{4} \)
(d) \( \frac{-4}{5} \)
(e) \( -5 \)

2. The graph of \( y = g(x) \) is shown, as well as the tangent line to the graph at \( x = 1 \). Determine \( g'(1) \).

\[ g'(1) = \text{Slope of tangent line at } x = 1. \]

But slope is \( \frac{4}{1} = 4 \).

Possibilities:

(a) -2
(b) 1/4
(c) 1
(d) 2
(e) 4
3. Let \( f(x) = 6x^2 + 4x - 5 \). Find an equation for the line through the points \((2, f(2))\) and \((5, f(5))\).

\[
\begin{align*}
  f(2) &= 6 \cdot 2^2 + 4 \cdot 2 - 5 = 27 \\
  f(5) &= 6 \cdot 5^2 + 4 \cdot 5 - 5 = 165 \\
\end{align*}
\]

Possibilities:

(a) \( y - 2 = 46x + 27 \)  
(b) \( y + 27 = 46(x + 2) \)  
(c) \( y = 46x - 119 \)  
(d) \( y - 2 = 46(x - 27) \)  
(e) \( y - 27 = 46(x - 2) \)

\[
\text{Slope} \quad \frac{165 - 27}{5 - 2} = \frac{138}{3} = 46.
\]

4. Find the average rate of change of \( f(x) = \frac{2}{x} \) from \( x = 5 \) to \( x = 9 \).

\[
\text{AROC} = \frac{f(9) - f(5)}{9 - 5} = \frac{\frac{2}{9} - \frac{2}{5}}{4}
\]

Possibilities:

(a) 0  
(b) 8/45  
(c) 2/45  
(d) −2/45  
(e) −8/45

5. Find the average rate of change of \( f(x) = 2x + 5 \) from \( x = 2 \) to \( x = 2 + h \).

\[
\text{AROC} = \frac{f(2+h) - f(2)}{h} = \frac{(2(2+h) + 5) - (2(2) + 5)}{h}
\]

Possibilities:

(a) \( h \)  
(b) \( 2h \)  
(c) \( -2h \)  
(d) 2  
(e) −2

Alternatively, \( \text{AROC} = 2 \) since \( f(x) \) is a linear function with \( \text{slope} = 2 \).
6. Find the derivative, \( f'(-1) \), where \( f(x) = x^2 - 2x + 7 \)

\[
f'(x) = 2x - 2
\]

Possibilities:
(a) 10
(b) 4
(c) \(-4\)
(d) 3
(e) \(-3\)

7. Let \( f(x) = 8x^2 + x - 9 \). Find the instantaneous rate of change of \( f(x) \) at \( x = 5 \).

\[
\text{Inst ROC} = f'(x)
\]

Possibilities:
(a) \( 81h + 8h^2 \)
(b) 0
(c) \( 81 + 8h \)
(d) 81
(e) The instantaneous rate of change cannot be computed with the given information.

8. Let \( f(x) = 9x^2 - 4x - 6 \). Find a value \( c \) in the interval \([5, 9]\) so that the average rate of change of \( f(x) \) from \( x = 5 \) to \( x = 9 \) is equal to the instantaneous rate of change of \( f(x) \) at \( x = c \).

\[
f(5) = 9 \cdot 5^2 - 4 \cdot 5 - 6 = 199
\]

\[
f(9) = 9 \cdot 9^2 - 4 \cdot 9 - 6 = 687
\]

\[
\text{AROC} = \frac{f(9) - f(5)}{9 - 5} = \frac{687 - 199}{4} = 122.
\]

Possibilities:
(a) 4
(b) 5
(c) 6
(d) 7
(e) 8

\[
\text{Inst ROC} = f'(c) = 2 \cdot 9c - 4 = 18c - 4.
\]

So \( \text{AROC} = \text{Inst ROC} \)

\[
122 = 18c - 4 \Rightarrow 18c = 126 \Rightarrow c = 7.
\]
9. Let \( f(x) = 3x^2 + 2x - 4 \). Find an equation for the tangent line to the curve \( y = f(x) \) at the point \( x = 3 \).

Point on Tangent Line is \((3, f(3))\)

\[
f(3) = 3 \cdot 3^2 + 2 \cdot 3 - 4 = 29, \text{ point is } (3, 29)
\]

Possibilities:

\[
\text{slope } = f'(3) = 2 \cdot 3 \cdot 3 + 2 = 20.
\]

Line is the

\[
y - 29 = 20(x - 3)
\]

10. A particle is traveling along a straight line. Its position, measured in feet, after \( t \) seconds is given by \( s(t) = 6t^2 + 202 \). Find the instantaneous velocity of the particle at time \( t = 1 \).

\[
\text{Inst. Velocity } = s'(t).
\]

\[
s'(t) = 2 \cdot 6 \cdot t = 12t
\]

\[
s'(1) = 12 \cdot 1 = 12.
\]

Possibilities:

(a) 202 feet per second
(b) 1 foot per second
(c) 208 feet per second
(d) 12 feet per second
(e) 6 feet per second

11. A car travels at 40 miles per hour from 8:00 am to 9:30 am. It then travels 100 miles from 9:30 to 11:30 am. What was the car’s average velocity from 8:00 am to 11:30 am?

\[
\begin{array}{ccc}
\text{8:00} & \text{9:30} & \text{11:30} \\
3/2 \text{ hr} & 2 \text{ hr} & \\
60 \text{ miles} & 100 \text{ miles} & \\
\end{array}
\]

Possibilities:

(a) 320/7 miles per hour
(b) 160 miles per hour
(c) 560 miles per hour
(d) 80 miles per hour
(e) 140 miles per hour

\[
\text{Average Velocity } = \frac{\text{Distance}}{\text{Time}}.
\]

\[
= \frac{100 + 60}{3/2 + 2} = \frac{160}{7/2} = \frac{320}{7}.
\]
12. Compute

\[ \lim_{t \to 4} \left( 7 - 2t + \frac{t^2}{t - 2} \right) \]

Denominator stays away from 0 as \( t \to 4 \), so limit is

\[ 7 - 2 \cdot 4 + \frac{4^2}{4-2} = 7 \]

Possibilities:

(a) 7
(b) 8
(c) 9
(d) 10
(e) The limit does not exist.

13. Compute \( \lim_{t \to 3} \frac{t^2 - 2t - 15}{t - 5} \)

Numerator and denominator both go to zero as \( t \to 5 \).

Need to simplify!

\[ \frac{t^2 - 2t - 15}{t - 5} = \frac{(t-5)(t+3)}{(t-5)} \]

\( \text{So } \lim_{t \to 5} \frac{t^2 - 2t - 15}{t - 5} = \lim_{t \to 5} (t+3) = 5+3 = 8 \)

Possibilities:

(a) 8
(b) 9
(c) 10
(d) 11
(e) The limit does not exist.

14. Compute \( \lim_{t \to 3} \frac{t^2 - 5t - 6}{t - 5} \)

Denominator, but not numerator, goes to zero as \( t \to 5 \), so limit does not exist.

Alternatively, limit does not exist since graph has vertical asymptote at \( x = 5 \).

Possibilities:

(a) 5
(b) 0
(c) 6
(d) -1
(e) The limit does not exist.
15. The graph of \( y = f(x) \) is shown below. Compute \( \lim_{{x \to 1^-}} f(x) \).

**Possibilities:**

(a) \(-2\)
(b) \(0\)
(c) \(1\)
(d) \(2\)
(e) \(4\)

16. Compute \( \lim_{{t \to 0^+}} \frac{|6t|}{t} \)

**Method 1:** \( t > 0 \Rightarrow 16t = 6t, \text{ so} \)
\[
\lim_{{t \to 0^+}} \frac{16t}{t} = \lim_{{t \to 0^+}} \frac{6t}{t} = 6.
\]

**Method 2:** Plug in \( t \) values near zero, but \( t > 0 \):
\[
t = 1 \Rightarrow \frac{|6 \cdot 0.1|}{0.1} = 6 \]  
\[
t = 0.1 \Rightarrow \frac{|6 \cdot 0.01|}{0.01} = 6
\]

**Method 3**
\[
\lim_{{t \to 0^+}} \frac{|6t|}{t} = 6.
\]

17. Find the value of \( A \) which makes \( f(x) \) continuous everywhere, where

\[
f(x) = \begin{cases} 
-4x + A, & \text{if } x \leq 2; \\
6x^3 - 3, & \text{if } x > 2 
\end{cases}
\]

**Possibilities:**

(a) \(53\)
(b) \(45\)
(c) \(-3\)
(d) \(8\)
(e) No such value of \( A \) exists

\[
\text{Need } \lim_{{x \to 2^+}} f(x) = \lim_{{x \to 2^-}} f(x)
\]
\[
\lim_{{x \to 2^+}} -4x + A = \lim_{{x \to 2^-}} 6x^3 - 3
\]
\[
-4 \cdot 2 + A = 6 \cdot 2^3 - 3
\]
\[
-8 + A = 45, \text{ so } A = 53
\]
18. Suppose 
\[-6x^2 - 8x + 10 = A + B(x - 1) + C(x - 1)^2.\]
Find A.

**Possibilities:**
(a) -7
(b) -6
(c) -5
(d) -4
(e) -3

\[\text{Plug in } x = 1: \]
\[-6 \cdot 1^2 - 8 \cdot 1 + 10 = A + B(1 - 1) + C(1 - 1)\]
\[-4 = A\]

19. Let \( f(x) = 8x^2 - 4x - 3 \). The tangent line to the curve \( y = f(x) \) at \( x = 2 \) is given by \( y = 28x + b \). Determine the value of \( b \).

**Possibilities:**

\[\text{One method: } f'(x) \text{ a tangent line at } x = 2 \text{ agrees}\]
\[\frac{df}{dx} \bigg|_{x=2} = 28 \text{ so}\]
\[f(2) = 28 \cdot 2 + b = 32 \cdot 2 - 4 = 41 \]
But \[f(2) = 8 \cdot 2^2 - 4 \cdot 2 - 3 = 21\]
So \[21 = 41 + b \Rightarrow b = -30\]

\[\text{Another method: } f'(2) = 28 \]
\[f(2) = 28 \cdot 2 - 4 = 28\]
\[\text{Tangent line is} \]
\[y - 21 = 28(x - 2)\]
\[\Rightarrow y = 28x - 56 + 21 = 28x - 35\]

20. Find all points where \( g(x) \) is not differentiable, where \( g(x) \) is defined by

\[g(x) = \begin{cases} 
  x^2 - 9x + 18, & \text{if } x \leq 3 \text{ or } x \geq 6; \\
  -x^2 + 9x - 18, & \text{if } 3 < x < 6 
\end{cases}\]

**Possibilities:**
(a) \( x = 6 \)
(b) \( x = 9 \)
(c) \( x = 3 \) and \( x = 6 \)
(d) \( g(x) \) is differentiable everywhere.
(e) \( x = 3 \)