MAT 285  Final Exam  May. 7, 2012  Ver A

Signature:

Instructions: Write the answers and show the main steps of your work on this test sheet. There are 11 questions on 14 pages (including this cover). Be sure you have all 14 pages (7 sheets) and that you do all 11 problems! The Final Exam is scored on a basis of 100 points.

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DO NOT WRITE ON THE REST OF THIS COVER SHEET!

Problem 1 (6)  Problem 6 (12)  Problem 8 (9)
Problem 2 (8)  Problem 7 (21)  Problem 9 (8)
Problem 3 (6)  Problem 10 (8)
Problem 4 (8)  Problem 11 (8)
Problem 5 (6)

Part 1 Total (34)  Part 2 Total (33)  Part 3 Total (33)

EXAM TOTAL(100)
Part I

Problem 1. (6 points) Circle the correct answer for each part.

(a) The ideal weight $w$, in pounds, vs height $h$, in feet is given by a linear equation consistent with the following data points:

<table>
<thead>
<tr>
<th>Height $h$ (ft.)</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight $w$ (lb.)</td>
<td>150</td>
<td>190</td>
</tr>
</tbody>
</table>

Consider the linear equation $w(h)$, weight as a function of height.

It has slope ____________

The units of its slope are (circle one):

- ft per lb
- $\text{ft}^2$ per lb
- lb per ft
- lb per $\text{ft}^2$
- none of these

(b) The distance of a moon from a certain planet is given by

$$d(t) = 325,000 + 41,000 \sin\left(\frac{2\pi t}{37.4}\right),$$

where time $t$ is measured in days and the distance $d(t)$ is measured in miles. The closest the moon gets to the planet is:

- 366,000 mi
- 325,000 mi
- 300,000 mi
- 284,000 mi
- none of these

(c) The equation of the line through $(1,1)$ perpendicular to the line

$$y = 1 - \frac{3}{4}x$$

is (circle one)

- $y = -\frac{3}{4}x + \frac{7}{4}$
- $y = \frac{3}{4}x + \frac{1}{4}$
- $x = 1 - \frac{3}{4}y$

- $y = \frac{4}{3}x - \frac{1}{3}$
- $y = -\frac{4}{3}x + \frac{2}{3}$

- none of these.
Problem 2. (8 points) When an antibiotic is introduced into a culture of 10,000 bacteria, the number of bacteria decreases exponentially. After 3 hours there are only 2,000 bacteria.

(a) Write the exponential equation for the number of bacteria remaining \( t \) hours after the introduction of the antibiotic. Include values for any constants, rounded to 2 decimal places.

(b) How many hours does it take for half of the population to die off? Round your answer to 2 decimal places.
Problem 3. (6 points) Solve each of the following equations for $x$. Give your answers exactly - not as a decimal approximation.

(a) $8^x = 128$

(b) $\log_x(81) = 4$
Problem 4. (8 points) Find the following limits; if a limit does not exist say so.

(a) \( \lim_{x \to 0} \frac{x - 5}{x^2 - 25} \)

(b) \( \lim_{x \to -2} \frac{x - 3}{x^2 - x - 6} \)

(c) \( \lim_{x \to 8} \frac{x - 9}{(x - 8)^2} \)

(d) \( \lim_{x \to \infty} \frac{4x^2 + 7}{3x^2 - 6x - 10} \)
Problem 5. (6 points) Consider the function $f(x)$ graphed below. In each part circle all that apply.

(a) At $x = a$, $f(x)$ is

continuous  discontinuous  undefined  differentiable

(b) At $x = b$, $f(x)$ is

continuous  discontinuous  undefined  differentiable

(c) At $x = c$, $f(x)$ is

continuous  discontinuous  undefined  differentiable
Part II

Problem 6. (12 points) Suppose that \( f(x) = x^3 - 5x^2 + 3x + 10 \). Then \( f'(x) = 3x^2 - 10x + 3 \) with roots at \( \frac{1}{3} \) and 3 and \( f''(x) = 6x - 10 \). SHOW YOUR WORK

(a) Is there an absolute maximum? Circle one: YES NO.

If YES, what is its \( x \)-value?

(b) Is there a relative minimum? Circle one: YES NO.

If YES, what is its \( x \)-value?

(c) Is there an inflection point? Circle one: YES NO.

If YES, what is its \( x \)-value?

(d) For what \( x \) values is this function decreasing?
Problem 7. (21 points) DO NOT SIMPLIFY YOUR ANSWERS!

(a) \( f(x) = \sin \left( \frac{\pi}{3} \cdot x \right) + \tan(x) \), compute \( f'(x) \)

(b) \( f(x) = \sqrt{x^2 - 4x + 5} \), compute \( f'(x) \)

(c) \( f(x) = (4x - 3)^{100}(\cos(x)) \), compute \( f'(x) \)

(d) \( f(x) = x^{-2.3} + \frac{1}{x} \), compute \( f'(x) \)
Problem 7 continued. DO NOT SIMPLIFY YOUR ANSWERS!

(e) \( f(x) = \frac{x^2 + 4x}{\ln x} \), compute \( f'(x) \)

(f) \( f(x) = \log_5 |(9x - 8)| \), compute \( f'(x) \)

(g) \( f(x) = -8 \cdot e^{(x^2+2)} \), compute \( f'(x) \)
Part III

Problem 8. (9 points) You wish to construct two identical $x$ foot by $y$ foot enclosures against a long stone fence as illustrated below:

\[
\begin{array}{cccc}
\text{STONE} & \text{FENCE} \\
\hline
x & x & x \\
y & y \\
\end{array}
\]

(a) Give a formula for the total area enclosed, $A$, in terms of $x$ and $y$.

(b) Give a formula for $F$, the total length of a fencing needed to build the enclosures in terms of $x$ and $y$.

(c) Find the dimensions of the enclosures of maximum area that can be enclosed with 300 feet of fencing. Show your work!
Problem 9. (8 points) A 40 foot flag pole leaning on the side of a building is being lowered at a constant rate of 3ft per minute. Its bottom is sliding away from the building. When the bottom of the pole is 32 feet from the side of the building, how fast is it sliding away from the building? You must SHOW YOUR WORK.
Problem 10. (8 points) Given the ellipse \( \frac{x^2}{25} + \frac{y^2}{16} = 1 \) find the equation of the tangent line at the point \( (4, \frac{12}{5}) \).
Problem 11. (8 points) Find all maxima, minima or saddle points for
$f(x, y) = 16x^3 + 3y^2 - 24xy + 5$
[Use this Sheet for Scratch]
MAT 285  Final Exam  May. 7, 2012  Ver B

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Part 1 Total (34)  Part 2 Total (33)  Part 3 Total (33)

EXAM TOTAL (100)
Part I

Problem 1. (6 points) Circle the correct answer for each part.

(a) The ideal weight \( w \), in pounds, vs height \( h \), in feet is given by a linear equation consistent with the following data points:

<table>
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<tr>
<th>Height ( h ) (ft.)</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight ( w ) (lb.)</td>
<td>150</td>
<td>200</td>
</tr>
</tbody>
</table>

Consider the linear equation \( w(h) \), weight as a function of height.

It has slope ____________

The units of its slope are (circle one):

- ft per lb
- ft\(^2\) per lb
- lb per ft
- lb per ft\(^2\)
- none of these

(b) The distance of a moon from a certain planet is given by

\[ d(t) = 366,000 + 41,000 \sin\left(\frac{2\pi t}{37.4}\right), \]

where time \( t \) is measured in days and the distance \( d(t) \) is measured in miles. The closest the moon gets to the planet is:

- 366,000 mi
- 325,000 mi
- 300,000 mi
- 284,000 mi
- none of these

(c) The equation of the line through \((1, 1)\) perpendicular to the line

\[ y = 1 + \frac{3}{4}x \]

is (circle one)

- \( y = -\frac{3}{4}x + \frac{1}{4} \)
- \( y = \frac{3}{4}x + \frac{1}{4} \)
- \( x = 1 - \frac{3}{4}y \)
- \( y = \frac{4}{3}x - \frac{1}{3} \)
- \( y = -\frac{4}{3}x + \frac{7}{3} \)
- none of these
Problem 2. (8 points) When an antibiotic is introduced into a culture of 10,000 bacteria, the number of bacteria decreases exponentially. After 3 hours there are only 4,000 bacteria

(a) Write the exponential equation for the number of bacteria remaining \( t \) hours after the introduction of the antibiotic. Include values for any constants, rounded to 2 decimal places.

(b) How many hours does it take for half of the population to die off? Round your answer to 2 decimal places.
Problem 3. (6 points) Solve each of the following equations for \( x \). Give your answers exactly - not as a decimal approximation.

(a) \( 8^x = 1024 \)

(b) \( \log_x(81) = 2 \)
Problem 4. (8 points) Find the following limits; if a limit does not exist say so. [SAME LIMITS PERMUTE ORDER]

(a) \( \lim_{x \to -2} \frac{x - 3}{x^2 - x - 6} \)

(b) \( \lim_{x \to 8} \frac{x - 9}{(x - 8)^2} \)

(c) \( \lim_{x \to \infty} \frac{4x^2 + 7}{3x^2 - 6x - 10} \)

(d) \( \lim_{x \to 0} \frac{x - 5}{x^2 - 25} \)
Problem 5. (6 points) Consider the function $f(x)$ graphed below. In each part circle all that apply.

(a) At $x = a$, $f(x)$ is

continuous  discontinuous  undefined  differentiable

(b) At $x = b$, $f(x)$ is

continuous  discontinuous  undefined  differentiable

(c) At $x = c$, $f(x)$ is

continuous  discontinuous  undefined  differentiable
Part II

Problem 6. (12 points) Suppose that \( f(x) = x^3 - 5x^2 + 3x + 10 \). Then \( f'(x) = 3x^2 - 10x + 3 \) with roots at \( \frac{1}{3} \) and 3 and \( f''(x) = 6x - 10 \). SHOW YOUR WORK

(a) Is there a relative minimum? Circle one: YES NO.

If YES, what is its \( x \)-value?

(b) Is there an inflection point? Circle one: YES NO.

If YES, what is its \( x \)-value?

(c) Is there an absolute maximum? Circle one: YES NO.

If YES, what is its \( x \)-value?

(d) For what \( x \) values is this function decreasing?
Problem 7. (21 points) DO NOT SIMPLIFY YOUR ANSWERS!

(a) \( f(x) = \sin \left( \frac{\pi}{6} \cdot x \right) + \tan(x), \) compute \( f'(x) \)

(b) \( f(x) = \sqrt{x^2 + x + 2}, \) compute \( f'(x) \)

(c) \( f(x) = (3x - 4)^{100} \cos(x), \) compute \( f'(x) \)

(d) \( f(x) = x^{-1.4} + \frac{1}{x}, \) compute \( f'(x) \)
Problem 7 continued. DO NOT SIMPLIFY YOUR ANSWERS!

(e) \( f(x) = \frac{x^2 + 3x}{\ln x} \), compute \( f'(x) \)

(f) \( f(x) = \log_3 |4x - 5| \), compute \( f'(x) \)

(g) \( f(x) = -4 \cdot e^{(x^2+3)} \), compute \( f'(x) \)
Part III

Problem 8. (9 points) You wish to construct two identical $x$ foot by $y$ foot enclosures against a long stone fence as illustrated below:

(a) Give a formula for the total area enclosed, $A$, in terms of $x$ and $y$.

(b) Give a formula for $F$, the total length of a fencing needed to build the enclosures in terms of $x$ and $y$.

(c) Find the dimensions of the enclosures of maximum area that can be enclosed with 600 feet of fencing. Show your work!
Problem 9. (8 points) A 40 foot flag pole leaning on the side of a building is being lowered at a constant rate of 3 ft per minute. Its bottom is sliding away from the building. When the bottom of the pole is 24 feet from the side of the building, how fast is it sliding away from the building? You must SHOW YOUR WORK.
Problem 10. (8 points) Given the ellipse \( \frac{x^2}{25} + \frac{y^2}{16} = 1 \) find the equation of the tangent line at the point \((-4, \frac{12}{5})\).
Problem 11. (8 points) Find all maxima, minima or saddle points for $f(x, y) = 16y^3 + 3x^2 - 24xy + 5$
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Part 1 Total (34)  Part 2 Total (33)  Part 3 Total (33)

EXAM TOTAL(100)
Part I

Problem 1. (6 points) Circle the correct answer for each part.

(a) The ideal weight $w$, in pounds, vs height $h$, in feet is given by a linear equation consistent with the following data points:

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<th>190</th>
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<tbody>
<tr>
<td>Height ($h$) (ft.)</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

Consider the linear equation $h(w)$, height as a function of weight.

It has slope ____________

The units of its slope are (circle one): ft per lb ft$^2$ per lb lb per ft lb per ft$^2$ none of these

(b) The distance of a moon from a certain planet is given by

$$d(t) = 300,000 + 16,000 \sin\left(\frac{2\pi t}{37.4}\right),$$

where time $t$ is measured in days and the distance $d(t)$ is measured in miles. The closest the moon gets to the planet is:

366,000 mi; 325,000 mi; 300,000 mi; 284,000 mi; none of these.

(c) The equation of the line through $(1,1)$ perpendicular to the line $y = 1 - \frac{4}{3}x$ is (circle one)

$y = -\frac{3}{4}x + \frac{7}{4}$; $y = \frac{3}{4}x + \frac{1}{4}$; $x = 1 - \frac{3}{4}y$

$y = \frac{4}{3}x - \frac{1}{3}$; $y = -\frac{4}{3}x + \frac{7}{3}$ none of these.
Problem 2. (8 points) When an antibiotic is introduced into a culture of 12,000 bacteria, the number of bacteria decreases exponentially. After 3 hours there are only 2,000 bacteria

(a) Write the exponential equation for the number of bacteria remaining \(t\) hours after the introduction of the antibiotic. Include values for any constants, rounded to 2 decimal places.

(b) How many hours does it take for half of the population to die off? Round your answer to 2 decimal places.
Problem 3. (6 points) Solve each of the following equations for $x$. Give your answers exactly - not as a decimal approximation.

(a) $8^x = 32$

(b) $\log_x(125) = 3$
Problem 4. (8 points) Find the following limits; if a limit does not exist say so. [SAME LIMITS PERMUTE ORDER]

(a) \( \lim_{x \to 8} \frac{x - 9}{(x - 8)^2} \)

(b) \( \lim_{x \to \infty} \frac{4x^2 + 7}{3x^2 - 6x - 10} \)

(c) \( \lim_{x \to 0} \frac{x - 5}{x^2 - 25} \)

(d) \( \lim_{x \to -2} \frac{x - 3}{x^2 - x - 6} \)
Problem 5. (6 points) Consider the function $f(x)$ graphed below. In each part circle all that apply.

(a) At $x = a$, $f(x)$ is

continuous  discontinuous  undefined  differentiable

(b) At $x = b$, $f(x)$ is

continuous  discontinuous  undefined  differentiable

(c) At $x = c$, $f(x)$ is

continuous  discontinuous  undefined  differentiable
Part II

Problem 6. (12 points) Suppose that \( f(x) = x^3 - 5x^2 + 3x + 10 \). Then \( f'(x) = 3x^2 - 10x + 3 \) with roots at \( \frac{1}{3} \) and 3 and \( f''(x) = 6x - 10 \). SHOW YOUR WORK

(a) Is there an absolute maximum? Circle one: YES NO.

If YES, what is its \( x \)-value?

(b) Is there an inflection point? Circle one: YES NO.

If YES, what is its \( x \)-value?

(c) Is there a relative minimum? Circle one: YES NO.

If YES, what is its \( x \)-value?

(d) For what \( x \) values is this function decreasing?
Problem 7. (21 points) DO NOT SIMPLIFY YOUR ANSWERS!

(a) \( f(x) = \sin \left( \frac{\pi}{4} \cdot x \right) + \tan(x) \), compute \( f'(x) \)

(b) \( f(x) = \sqrt{x^2 + 3x + 8} \), compute \( f'(x) \)

(c) \( f(x) = (3x - 5)^{100} \cos(x) \), compute \( f'(x) \)

(d) \( f(x) = x^{-2.6} + \frac{1}{x} \), compute \( f'(x) \)
Problem 7 continued.  DO NOT SIMPLIFY YOUR ANSWERS!

(e) \( f(x) = \frac{x^2 + 2x}{\ln x} \), compute \( f'(x) \)

(f) \( f(x) = \log_5 |(3x - 7)| \), compute \( f'(x) \)

(g) \( f(x) = -6 \cdot e^{(x^2 + 8)} \), compute \( f'(x) \)
Part III

Problem 8. (9 points) You wish to construct two identical $h$ foot by $k$ foot enclosures against a long stone fence as illustrated below:

(a) Give a formula for the total area enclosed, $A$, in terms of $h$ and $k$.

(b) Give a formula for $F$, the total length of a fencing needed to build the enclosures in terms of $h$ and $k$.

(c) Find the dimensions of the enclosures of maximum area that can be enclosed with 300 feet of fencing. Show your work!
Problem 9. (8 points) A 40 foot flag pole leaning on the side of a building is being lowered at a constant rate of 4 ft per minute. Its bottom is sliding away from the building. When the bottom of the pole is 32 feet from the side of the building, how fast is it sliding away from the building? You must SHOW YOUR WORK.
Problem 10. (8 points) Given the ellipse \( \frac{x^2}{25} + \frac{y^2}{16} = 1 \) find the equation of the tangent line at the point \( (3, \frac{16}{5}) \).
Problem 11. (8 points) Find all maxima, minima or saddle points for
\[ f(x, y) = 16x^3 + 12y^2 - 48xy + 5 \]
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Signature:

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EXAM TOTAL(100)
Part I

Problem 1. (6 points) Circle the correct answer for each part.

(a) The ideal weight \( w \), in pounds, vs height \( h \), in feet is given by a linear equation consistent with the following data points:

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<th>Weight ( w ) (lb.)</th>
<th>150</th>
<th>200</th>
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<tbody>
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<td>Height ( h ) (ft.)</td>
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<td>6</td>
</tr>
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</table>

Consider the linear equation \( h(w) \), height as a function of weight.

It has slope ____________

The units of its slope are (circle one):

- ft per lb
- \( \text{ft}^2 \) per lb
- lb per ft
- \( \text{lb} \) per \( \text{ft}^2 \)
- none of these

(b) The distance of a moon from a certain planet is given by

\[
d(t) = 325,000 + 25,000 \sin\left(\frac{2\pi t}{37.4}\right),
\]

where time \( t \) is measured in days and the distance \( d(t) \) is measured in miles. The closest the moon gets to the planet is:

- 366,000 mi;
- 325,000 mi;
- 300,000 mi;
- 284,000 mi;
- none of these.

(c) The equation of the line through \((1,1)\) perpendicular to the line \( y = 1 + \frac{4}{3}x \) is (circle one)

\[
y = -\frac{3}{4}x + \frac{7}{4}; \quad y = \frac{3}{4}x + \frac{1}{4}; \quad x = 1 - \frac{3}{4}y;
\]
\[
y = \frac{4}{3}x - \frac{1}{3}; \quad y = -\frac{4}{3}x + \frac{7}{3} \quad \text{none of these.}
Problem 2. (8 points) When an antibiotic is introduced into a culture of 12,000 bacteria, the number of bacteria decreases exponentially. After 3 hours there are only 4,000 bacteria.

(a) Write the exponential equation for the number of bacteria remaining $t$ hours after the introduction of the antibiotic. Include values for any constants, rounded to 2 decimal places.

(b) How many hours does it take for half of the population to die off? Round your answer to 2 decimal places.
Problem 3. (6 points) Solve each of the following equations for \( x \). Give your answers exactly - not as a decimal approximation.

(a) \( 8^x = 256 \)

(b) \( \log_x(625) = 4 \)
Problem 4. (8 points) Find the following limits; if a limit does not exist say so. [SAME LIMITS PERMUTE ORDER]

(a) \( \lim_{x \to \infty} \frac{4x^2 + 7}{3x^2 - 6x - 10} \)

(b) \( \lim_{x \to 0} \frac{x - 5}{x^2 - 25} \)

(c) \( \lim_{x \to -2} \frac{x - 3}{x^2 - x - 6} \)

(d) \( \lim_{x \to 8} \frac{x - 9}{(x - 8)^2} \)
Problem 5. (6 points) Consider the function $f(x)$ graphed below. In each part circle all that apply.

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Part II

Problem 6. (12 points) Suppose that $f(x) = x^3 - 5x^2 + 3x + 10$. Then $f'(x) = 3x^2 - 10x + 3$ with roots at $\frac{1}{3}$ and 3 and $f''(x) = 6x - 10$. SHOW YOUR WORK

(a) Is there an inflection point? Circle one: YES NO.

If YES, what is its $x$-value?

(b) Is there an absolute maximum? Circle one: YES NO.

If YES, what is its $x$-value?

(c) Is there a relative minimum? Circle one: YES NO.

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Problem 7. (21 points) DO NOT SIMPLIFY YOUR ANSWERS!

(a) \( f(x) = \sin \left( \frac{\pi}{5} \cdot x \right) + \tan(x) \), compute \( f'(x) \)

(b) \( f(x) = \sqrt{x^2 - x + 5} \), compute \( f'(x) \)

(c) \( f(x) = (5x - 3)^{100}(\cos(x)) \), compute \( f'(x) \)

(d) \( f(x) = x^{-1.7} + \frac{1}{x} \), compute \( f'(x) \)
Problem 7 continued. DO NOT SIMPLIFY YOUR ANSWERS!

(e) \( f(x) = \frac{x^2 + 5x}{\ln x} \), compute \( f'(x) \)

(f) \( f(x) = \log_3 |(7x - 6)| \), compute \( f'(x) \)

(g) \( f(x) = -10 \cdot e^{(x^2+6)} \), compute \( f'(x) \)
Part III

Problem 8. (9 points) You wish to construct two identical \( h \) foot by \( k \) foot enclosures against a long stone fence as illustrated below:

\[
\begin{array}{ccc}
\text{S T O N E} & \text{F E N C E} \\
\hline \\
h & h & h \\
\hline \\
k & k \\
\end{array}
\]

(a) Give a formula for the total area enclosed, \( A \), in terms of \( h \) and \( k \).

(b) Give a formula for \( F \), the total length of a fencing needed to build the enclosures in terms of \( h \) and \( k \).

(c) Find the dimensions of the enclosures of maximum area that can be enclosed with 600 feet of fencing. Show your work!
Problem 9. (8 points) A 40 foot flag pole leaning on the side of a building is being lowered at a constant rate of 4ft per minute. Its bottom is sliding away from the building. When the bottom of the pole is 24 feet from the side of the building, how fast is it sliding away from the building? You must SHOW YOUR WORK.
Problem 10. (8 points) Given the ellipse \( \frac{x^2}{25} + \frac{y^2}{16} = 1 \) find the equation of the tangent line at the point \((-3, \frac{16}{5})\).
Problem 11. (8 points) Find all maxima, minima or saddle points for 
$f(x, y) = 16y^3 + 12x^2 - 48xy + 5$
[Use this Sheet for Scratch]