University of Pennsylvania
Math 103 Final Exam Fall 2016

First and Last Name ________________________________(PRINT) Penn ID________________

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Professor **(circle one):** **Barr** **Simmons** **Wilson**

This exam has 15 multiple choice questions. Each question is worth 10 points for a total of 150 points. Partial credit will be given for the entire exam so be sure to show all work. **CIRCLE** the correct answer and give **CLEAR** supporting work; a correct answer with little or no supporting work will receive little or no credit. Use the space provided to show all work. The back of each page is blank to give you extra room; if you want us to look at the other side, indicate this.

You have **120 minutes** to complete the exam. You are not allowed the use of a calculator or any other electronic device. You are allowed to use the front and back of a standard 8.5"X11" sheet of paper for handwritten notes. Please silence and put away all cell phones and other electronic devices.

Do **NOT** write in the grid below. It is for grading purposes only.

Problem	Points	Problem	Points
1		9	
2		10	
3		11	
4		12	
5		13	
6		14	
7		15	
8			
Total			

My signature below certifies that I have complied with the University of Pennsylvania's Code of Academic Integrity in completing this examination paper.

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Name (printed)

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MATH 103 – Final Exam - Fall 2016

1. A box with an open top is to be constructed from a rectangular piece of cardboard with dimensions of 6 inches by 26 inches by cutting out equal squares of side x at each corner and then folding up the sides. Express the volume V of the box as function of x.

(a) $x^3 - 64x^2 + 156x$ (b) $4x^3 + 64x^2 + 156x$ (c) $x^3 - 32x^2 + 156x$
(d) $4x^3 - 64x^2 + 156x$ (e) $x^3 - 64x^2 - 156x$ (f) $4x^3 + 32x^2 + 156x$

2. The following table gives values of three functions (f, g, and h). Which equation accurately describes the relationship of h to the other functions?

x	1	2	3	4	5	6
$f(x)$	2	1	0	1	2	3
$g(x)$	5	3	6	4	6	5
$h(x)$	2	0	3	1	3	2

(a) $h = 2f + g$ (b) $h = g \circ f$ (c) $h = f + g$ (d) $h = f \circ g$ (e) $h = f - 2g$ (f) $h = f \circ f$

3. If f and g are continuous functions with $f(5) = 5$ and $\lim_{x \to 5}[2f(x) - g(x)] = 6$, find $g(5)$.

(a) $g(5) = 4$ (b) $g(5) = 5$ (c) $g(5) = 16$ (d) $g(5) = 8$ (e) $g(5) = 2$ (f) $g(5) = 6$

4.

$$f(x) = \begin{cases} (x-2)^3 & \text{if } x \leq 0 \\ (x+4)^3 & \text{if } x > 0 \end{cases}$$

i. Find the point at which f is discontinuous:

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

ii. At the point of discontinuity, the function is:

(a) Continuous only from the right
(b) Continuous only from the left
(c) Continuous both from left and right
(d) Neither continuous from the left nor the right

5. Find the value of the limit

$$\lim_{x \to 0^+} x^{(x^2)}$$

(a) 1 (b) ∞ (c) e (d) 8 (e) 0 (f) 2

6. The top of a 10-foot-long ladder is sliding down a wall at a rate of 2 feet per second. How fast is the bottom of the ladder moving away from the wall when the top of the ladder is 6 feet above the floor?

(a) 2 ft/s (b) 1 ft/s (c) $\frac{3}{8}$ ft/s (d) $\frac{1}{2}$ ft/s (e) $\frac{3}{2}$ ft/s (f) 3 ft/s

7. The equation $e^y + y(x-2) = x^2 - 8$ implicitly defines y as a function of x near the point $(3, 0)$. Using linearization to estimate the value of y when $x = 2.8$, one gets:

(a) $-.8$ (b) $-.6$ (c) $-.4$ (d) $.4$ (e) $.6$ (f) None of the above

8. At which values of x in the interval $[-1, 2]$ does the function $f(x) = 2x^3 - 4x - 1$ attain the absolute maximum and the absolute minimum?

(a) abs. max. at $x = -\sqrt{\frac{2}{3}}$ and abs. min. at $x = \sqrt{\frac{2}{3}}$

(b) abs. max. at $x = -1$ and abs. min. at $x = \sqrt{\frac{2}{3}}$

(c) abs. max. at $x = 2$ and abs. min. at $x = \sqrt{\frac{2}{3}}$

(d) abs. max. at $x = 2$ and abs. min. at $x = -1$

(e) abs. max. at $x = -\sqrt{\frac{2}{3}}$ and abs. min. at $x = -1$

(f) None of the above

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9. A runner starts a race with velocity 0 and crosses the finish line going 10 mi/h. If the runner completed the 6.2 mile race in 30 minutes, which of the following is guaranteed to be true?

(a) The runner was moving 11 mi/h at least twice.

(b) The area between the velocity curve and the time axis is less than or equal to 6.

(c) The runner was moving 15 mi/h at least once.

(d) Both (a) and (c)

(e) Both (b) and (c)

(f) All of (a), (b), and (c)

10. Consider the function $f(x) = \frac{\ln(x+1)}{\sqrt{x+1}}$. Which of the following are true?

(a) f has a horizontal asymptote.

(b) f has two critical points.

(c) f has a point of inflection.

(d) f has a vertical asymptote.

(e) (b), (c), and (d)

(f) (a), (c), and (d)

(g) (a),(b), (c), and (d)

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11. What is the point (x, y) on the line $y = 1 - 3x$ such that the distance from the point to the origin $(0,0)$ is as small as possible? You must use differentiation as part of your solution. The distance between two points (x_0, y_0) and (x_1, y_1) is given by $\sqrt{(x_1 - x_0)^2 + (y_1 - y_0)^2}$.

(a) $(0,1)$ (b)$(\frac{3}{10}, \frac{1}{10})$ (c) $(\frac{1}{5}, \frac{2}{5})$ (d) $(\frac{3}{8}, \frac{-1}{8})$ (e) $(\frac{1}{2}, \frac{-1}{2})$ (f) $(\frac{1}{10}, \frac{7}{10})$

12.

i. Find the following derivative: $\frac{d}{dx}\int_{\tan x}^{1} 3t^2\, dt$

(a) $3\tan^2(x)\sec^2(x)$ (b) $-3\tan^2(x)\sec^2(x)$ (c) $\tan^2(x)\sec^2(x)$
(d) $-\tan^2(x)\sec^2(x)$ (e) $3\cot^2(x)\csc^2(x)$ (f) $-3\cot^2(x)\csc^2(x)$

ii. Find the following indefinite integral: $\int \frac{1}{1+(3x+1)^2}dx$

(a) $\ln(1+(3x+1)^2)+C$ (b) $\arctan((3x+1)^2)+C$ (c) $\arcsin((3x+1)^2)+C$
(d) $\frac{(3x+1)^2}{3}+C$ (e) $\frac{\arctan(3x+1)}{3}+C$ (f) $1+(3x+1)^2+C$

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13. Suppose that $\int_{-1}^{3} f(x)dx = 4$ and $\int_{5}^{3} f(x)dx = 1$. Find $\int_{5}^{-1}(2f(x) - 3)dx$.

(a) -10 (b) 0 (c) 3 (d) 6 (e) 10 (f) 12

14. What is the average value of the function $f(x) = xe^{x^2}$ on the interval $[1, 3]$?

(a) $\frac{1}{4}(e^3 - e)$ (b) $\frac{1}{4}(e^9 - e)$ (c) $\frac{1}{2}(e^9 - e)$ (d) $\frac{1}{2}e^9$ (e) $e^9 - e$ (f) None of the above.

15. What is the area of the region that is below both of the curves $y = \sin x$ and $y = \cos x$ but above the x-axis from $x = 0$ to $x = \pi/2$?

(a) $\frac{1}{2}$ (b) $\sqrt{2}$ (c) $\frac{\pi}{4}$ (d) $2 - \sqrt{2}$ (e) 1 (f) $\frac{\pi}{3}$