Name: ______________________ Section and/or TA: ______________

Do not remove this answer page. You will return the whole exam. You will be allowed two hours to complete this test. 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 communication capabilities is permitted. You may not use a phone or other communication device during the exam.

The exam consists of 12 multiple choice questions that are worth 5 points each and 4 free response questions that are worth 10 points each. You should work the multiple choice questions on the question page. After you have checked your work carefully, record your answers by completely filling in the circle below that corresponds to your answer. If you must change your answer, make a note on the front of the exam. Be sure to check carefully when you transfer your answers to the cover sheet.

Show all work to receive full credit on the free response problems.

Multiple Choice Questions

1 (A) (B) (C) (D) (E) **7** (A) (B) (C) (D) (E)

2 (A) (B) (C) (D) (E) **8** (A) (B) (C) (D) (E)

3 (A) (B) (C) (D) (E) **9** (A) (B) (C) (D) (E)

4 (A) (B) (C) (D) (E) **10** (A) (B) (C) (D) (E)

5 (A) (B) (C) (D) (E) **11** (A) (B) (C) (D) (E)

6 (A) (B) (C) (D) (E) **12** (A) (B) (C) (D) (E)

SCORE

Multiple Choice	13	14	15	16	Total Score
60	10	10	10	10	100

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Multiple Choice Questions

1. (5 points) The volume of a sphere of radius r is $V = \frac{4}{3}\pi r^3$. Suppose that at a certain time, $r = 2$ centimeters, and the radius is increasing at rate of 3 centimeters/second. Find the rate of change of the volume at this time.

   A. 48π cubic centimeters per second

   B. 36π cubic centimeters per second

   C. 54π cubic centimeters per second

   D. 32π cubic centimeters per second

   E. 72π cubic centimeters per second

2. (5 points) Suppose a population at time t consists of $P(t) = 20e^{0.06t}$ individuals. Find the time it takes for the population to triple.

   A. 1/0.02

   B. ln(3)/0.06

   C. ln(0.06)/3

   D. 20/3

   E. 60

3. (5 points) Let $f(x) = \dfrac{1}{1+x}$. Find the quadratic approximation to f at $x = 0$.

A. $1 - x - \dfrac{x^2}{2}$

B. $1 - x + x^2$

C. $1 - x - x^2$

D. $1 + x + x^2$

E. $-1/4$

4. (5 points) For which value of x does $f(x) = x^5 - x^3$ have a local maximum at x?

A. $-\sqrt{3/5}$

B. 0

C. $\sqrt{3/10}$

D. $\sqrt{3/5}$

E. $-\sqrt{3/10}$

5. (5 points) Let $f(x) = x^2 - 8x + 3$ on the interval $[3, 7]$. Find the value c so that the global (or absolute) maximum value for f on the interval $[3, 7]$ is at c.

   A. 4

   B. 7

   C. 6

   D. 3

   E. 5

6. (5 points) The *derivative* of f is $f'(x) = x(x-2)(x-3)$. Find the interval or intervals where f is decreasing.

   A. $(0, 2)$ and $(3, \infty)$

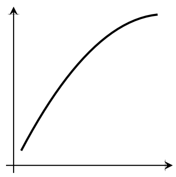
   B. $(3, \infty)$

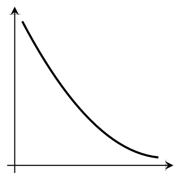
   C. $(-\infty, 0)$ and $(3, \infty)$

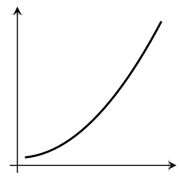
   D. $(0, 2)$

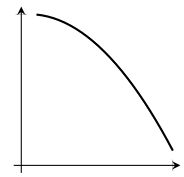
   E. $(-\infty, 0)$ and $(2, 3)$

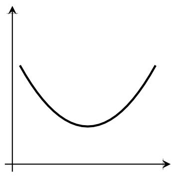
7. (5 points) Select the graph of the function which is decreasing and concave down.

A. 

B. 

C. 

D. 

E. 

8. (5 points) Find the horizontal and vertical asymptotes of the function $f(x) = \dfrac{3x^2+1}{2x-3}$

A. Vertical asymptote at $x = 2/3$, horizontal asymptote at $y = 3/2$

B. Vertical asymptote at $x = 3/2$, horizontal asymptote at $y = 2/3$

C. Vertical asymptote at $x = 3/2$, horizontal asymptote at $y = 0$

D. Vertical asymptote at $x = 3/2$, no horizontal asymptote

E. Vertical asymptote at $x = 3/2$, horizontal asymptote at $y = 3/2$

9. (5 points) Find the limit $\lim_{x \to 0} \frac{\sin(4x)}{\sin(2x)}$.

   A. 4

   B. 1/2

   C. 2

   D. 1/4

   E. Does not exist

10. (5 points) Consider the limit $\lim_{x \to 1} \frac{x^2 + \sin(\pi x) - K}{x - 1}$. Find the value of K so that the limit exists and is a finite number.

   A. π

   B. 1

   C. 0

   D. 2

   E. $\pi + 1$

11. (5 points) Find the general anti-derivative of $f(x) = x + \dfrac{1}{1+x^2}$.

A. $1 + \dfrac{-2x}{1+x^2} + C$

B. $2x^2 + \ln(1+x^2) + C$

C. $\dfrac{x^2}{2} + \arctan(x) + C$

D. $\dfrac{x^2}{2} + \ln(1+x^2) + C$

E. $2x^2 + \arctan(x) + C$

12. (5 points) Let $f(x) = \sin(x) + \cos(x)$. Find F, an anti-derivative of f with $F(0) = 2$.

A. $F(x) = 3 - \sin(x) - \cos(x)$

B. $F(x) = 1 - \sin(x) + \cos(x)$

C. $F(x) = 1 + \sin(x) + \cos(x)$

D. $F(x) = 2 - \sin(x) + \cos(x)$

E. $F(x) = 3 + \sin(x) - \cos(x)$

Free response questions, show all work

13. (10 points) The half-life of a radioactive substance is 6000 years. This means that its mass will decrease to half its original value after 6000 years.

    (a) Find the decay rate k so that $M(t) = M_0 e^{-kt}$ gives the mass of M after t years.

    (b) Suppose that $M(T) = \dfrac{1}{10} M(0)$. Find T.

14. (10 points) A 4 meter ladder leans against a wall. The bottom of the ladder is sliding away from the wall at 0.3 meter/second. When the base of the ladder is 1 meter from the wall, find the speed of the top of the ladder as it slides on the wall.

    (a) Make a sketch summarizing the information in the problem. Label the quantities you use in your solution.

    (b) Find the height of the top of the ladder when the base of the ladder is 1 meter away from the wall.

    (c) Find the speed of the top of the ladder when the base of the ladder is 1 meter from the wall. Is the top of the ladder moving up or down?

15. (10 points) Let $f(x) = xe^{-2x}$. Use calculus to find the following.
    (a) The intervals of increase or decrease.
    (b) Each value x where f has a local maximum and each value x where f has a local minimum. Explain how you determine if each is a local maximum or minimum.
    (c) The intervals of concavity.
    (d) The inflection point(s).

16. (10 points) Suppose we construct a right circular cylinder radius r and height h and total surface area of 150π square centimeters. Use calculus to find the dimensions r and h of the cylinder with the largest volume.

    The volume of the cylinder is $\pi r^2 h$ and the surface area is $2\pi rh + 2\pi r^2$.