1. Given \( f(x) = x^3 \ln x \), find \( f'(e) \)

   a) \( e \)  
   b) \( 3 + 3e^2 \)  
   c) \( e^2 \)  
   d) \( 3e \)  
   e) \( 4e^2 \)  

2. \( \frac{d}{dx}(\tan^{-1}(x^2)) = \)

   a) \( \frac{2x}{1 + x^4} \)  
   b) \( \frac{2}{1 + x^2} \)  
   c) \( -2x \csc(x^2) \cot(x^2) \)  
   d) \( 2x \tan^{-1}(x^2) \sec^{-1}(x^2) \)  
   e) \( \frac{2x}{1 + x^2} \)  

3. Find the value of \( c \) that satisfies the Mean Value Theorem for \( f(x) = x^2 + 4 \) on the interval \([-1, 2]\).

   a) \( \frac{7}{4} \)  
   b) \( \frac{2}{3} \)  
   c) \( \frac{1}{3} \)  
   d) \( 1 \)  
   e) \( \frac{1}{2} \)  

4. The graph of the DERIVATIVE of a function is shown below. On which intervals is the original function \( f \) concave down?

   CIRCLE ALL CORRECT CHOICES-THERE MAY BE MORE THAN ONE!

   a) \( (-\infty, -5) \)  
   b) \( (-5, 0) \)  
   c) \( (0, 4) \)  
   d) \( (4, \infty) \)  
   e) none of these intervals
5. Circle ALL the critical values of \( f(x) = x(x-1)^{\frac{2}{3}} \)

**NOTE: YOU MAY CIRCLE MORE THAN ONE CHOICE!**

- a) 0
- b) \( \frac{1}{3} \)
- c) \( \frac{1}{4} \)
- d) \( \frac{3}{4} \)
- e) 1

6. Find the absolute maximum of \( f(x) = \sin x + \cos x \) on the interval \([0, \pi/3]\).

**NOTE: \( \sqrt{2} \approx 1.414 \) and \( \sqrt{3} \approx 1.73 \)**

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

7. The inflection points of \( f(x) = x^5 + 10x^4 \) occur at which of the following?

- a) \( x = 6 \) only
- b) \( x = -6 \) only
- c) \( x = 0, x = -8 \)
- d) \( x = 0, x = -6 \)
- e) \( x = 0, x = 6 \)

8. Which is an antiderivative of \( f(x) = 2\sqrt{x} + \frac{1}{x^2} \)?

- a) \( \frac{4}{3} x^{\frac{3}{2}} - \frac{1}{x} + C \)
- b) \( \frac{4}{3} x^{\frac{3}{2}} - \ln(x^2) + C \)
- c) \( \frac{1}{\sqrt{x}} - \frac{2}{x^3} + C \)
- d) \( \frac{1}{\sqrt{x}} + \ln(x^2) + C \)
- e) \( \frac{1}{\sqrt{x}} - \frac{1}{x} + C \)

9. Write \( \frac{1}{2} - \frac{1}{4} + \frac{1}{8} - \frac{1}{16} + \frac{1}{32} - \frac{1}{64} \) in summation notation.

- a.) \( \sum_{n=1}^{6} \frac{(-1)^{n+1}}{2^n} \)
- b.) \( \sum_{n=1}^{6} \frac{(-1)^n}{2^n} \)
- c.) \( \sum_{n=1}^{6} \frac{(-1)^{n+1}}{2n} \)
- d.) \( \sum_{n=1}^{6} \frac{(-1)^n}{2n} \)
- e.) \( \sum_{n=1}^{6} \frac{-1}{2^n} \)
10. Approximate the area under the graph of \( f(x) = \ln x \), above the \( x \)-axis on the interval \([1, 3]\) using 4 subintervals of equal width and midpoints.

a.) \( \ln \frac{3465}{256} \)

b.) \( \frac{1}{2} \ln \frac{3465}{256} \)

c.) \( \frac{1}{2} \ln \frac{32}{16} \)

d.) \( \ln \frac{32}{16} \)

e.) None of the above.

11. Find \( \lim_{x \to 0} \frac{\arctan x - x}{x^3} \)

a.) \( -\frac{1}{3} \)

b.) \( -\frac{1}{2} \)

c.) 0

d.) \( \infty \)

e.) -6
Part II - Work Out Problems

12. Find the derivative of \( f(x) = x \sec x + 2 \arcsin x \)

13. Find \( \lim_{x \to 0} (1 - x)^{\frac{5}{x}} \)

14. On what intervals is \( f(x) = x + 2 \cos x, \ 0 \leq x \leq 2\pi \), increasing?

15. Find the intervals of concavity for \( f(x) = xe^{4x} \)

16. Find the dimensions of the largest rectangle that can be inscribed in a circle of radius 2.

17. The acceleration of a particle is given by \( \mathbf{a}(t) = (1 + e^t)\mathbf{i} + (\cos t)\mathbf{j} \). If the initial velocity is \( \mathbf{i} \) and the initial position is \( \mathbf{j} \), find the position of the particle at any time \( t \).

18. A thermometer is taken from a room where the temperature is 75° to the outdoors, where the temperature is 35°. After one minute, the thermometer reads 60°. What is the reading of the thermometer at time \( t \)?

19. By introducing a deadly chemical, the population of a particular bacteria culture is decreasing over time. Suppose it has been determined that the rate of change of the population at time \( t \) minutes is \( \frac{1}{3} \) of the population. If the initial size of the population is 1000 bacteria, how many bacteria are present after 3 minutes?

20. Find the following:
   
   a.) \( \arccos \left( \frac{1}{2} \right) = \) ______
   
   b.) \( \sin(\arccos \left( -\frac{4}{5} \right)) = \) ______
   
   c.) \( \arcsin(\sin \left( \frac{5\pi}{6} \right)) = \) ______
   
   d.) The domain of \( \arccos(4x - 5) = \) ______
   
   e.) \( \cos(\arctan x) = \) ______