**Instructions**
Read today's Notes and Learning Goals.
Find all the following basic derivatives. Any letter other than $x$ is a constant. You should be able to compute all derivatives in this list quickly.

$$\frac{d}{dx}(C) = \quad \frac{d}{dx}(x^n) = \quad \frac{d}{dx}(e^x) =$$
$$\frac{d}{dx}(\sin(x)) = \quad \frac{d}{dx}(\cos(x)) = \quad \frac{d}{dx}(\ln(x)) =$$
$$\frac{d}{dx}(\tan(x)) = \quad \frac{d}{dx}(\sec(x)) =$$

**Important!** You must enter in the derivatives for tangent and secant in the simplified form given in the Notes and Learning Goals. Be able to compute these basic derivatives quickly using this simplification.
2. Question Details

Let \( f(x) = x^5 \). Find the higher order derivatives of this function as follows.

a. Take the derivative of \( f(x) \) to find the first derivative.
\[
\frac{df}{dx} = \text{[Fill in the derivative]}
\]

b. Take the derivative of the first derivative to find the second derivative.
\[
\frac{d^2f}{dx^2} = \text{[Fill in the derivative]}
\]

c. Take the derivative of the second derivative to find the third derivative.
\[
\frac{d^3f}{dx^3} = \text{[Fill in the derivative]}
\]

d. Take the derivative of the third derivative to find the fourth derivative.
\[
\frac{d^4f}{dx^4} = \text{[Fill in the derivative]}
\]

3. Question Details

Find the first four higher order derivatives of \( f(x) = \ln(x) \).

- \[
\frac{df}{dx} = \text{[Fill in the derivative]}
\]
- \[
\frac{d^2f}{dx^2} = \text{[Fill in the derivative]}
\]
- \[
\frac{d^3f}{dx^3} = \text{[Fill in the derivative]}
\]
- \[
\frac{d^4f}{dx^4} = \text{[Fill in the derivative]}
\]
4. **Question Details**

Find the first four higher order derivatives of \( f(x) = \sin(3x) \).

- \( f'(x) = \)
- \( f''(x) = \)
- \( f^{(3)}(x) = \)
- \( f^{(4)}(x) = \)

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5. **Question Details**

Find the first and second derivative of \( f(x) = \sec(x) \).

- Find the first derivative. Your answer must be simplified as in the [Notes and Learning Goals](#).
  
  \[ f'(x) = \]

- Find the second derivative. You do not need to simplify.
  
  \[ f''(x) = \]
6. Question Details

Find the first and second derivative of \( f(x) = \tan(x) \).

- Find the first derivative. Your answer must be simplified as in the Notes and Learning Goals.
  \[ f'(x) = \]

- Find the second derivative. You do not need to simplify.
  \[ f''(x) = \]

7. Question Details

Find the first three derivatives of \( f(x) = e^{-x^2} \).

- \[ \frac{df}{dx} = \]

- \[ \frac{d^2f}{dx^2} = \]

- \[ \frac{d^3f}{dx^3} = \]

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8. **Question Details**

Find the first two derivatives of \( f(x) = \frac{1}{1 + x^2} \).

- \( f'(x) = \) 
- \( f''(x) = \)

9. **Question Details**

For the function \( f(x) = x \tan(x) - x^2 \), find \( f''(x) \).

\( f''(x) = \)

10. **Question Details**

For the function \( f(x) = x \sin(x) \), find \( \frac{d^3 f}{dx^3} \).

\[ \frac{d^3 f}{dx^3} = \]
The height of a moving object is given by
\[ h(t) = e^{-0.3t} \sin(5t) \]
where \( h \) is in cm and \( t \) is in seconds.

Compute the derivative.
\[ \frac{dh}{dt} = \]

Compute the second derivative.
\[ \frac{d^2h}{dt^2} = \]

What is the correct measurement unit for the second derivative \( \frac{d^2h}{dt^2} \)?
- cm/sec
- sec
- cm/sec^2
- cm
Many population growth models use a **logistic curve**. For example, suppose a population of rabbits grows according to

\[ P(t) = \frac{1000e^{0.12t}}{19 + e^{0.12t}} \]

where \( P \) is in rabbits and \( t \) is in months.

Compute the derivative.

\[ \frac{dP}{dt} = \]

Compute the second derivative.

\[ \frac{d^2P}{dt^2} = \]

What is the correct measurement unit for the second derivative \( \frac{d^2P}{dt^2} \)?

- rabbits/month
- months
- rabbits
- rabbits/month\(^2\)
Suppose the second derivative of a function is given as
\[ \frac{d^2f}{dx^2} = \sin(2x) \]

a. Four students guess what the original function \( f \) is. Find the second derivative of each student's guess to check them.

- **Alice** guesses that \( f(x) = 4\sin(2x) \).
  
  Check:  

- **Bob** guesses that \( f(x) = \frac{1}{4}\sin(2x) \).
  
  Check:  

- **Chris** guesses that \( f(x) = -\frac{1}{4}\sin(2x) \).
  
  Check:  

- **Dani** guesses that \( f(x) = -4\sin(2x) \).
  
  Check:  

b. Which of the four students are correct? Select all that apply.

- [ ] Alice
- [ ] Bob
- [ ] Chris
- [ ] Dani
Suppose the second derivative of a function is given as
\[
\frac{d^2 f}{dx^2} = x^3
\]

a. Four students guess what the original function \( f \) is. Find the second derivative of each student's guess to check them.

- **Alice** guesses that \( f(x) = 6x \).

  Check: \( \square \)

- **Bob** guesses that \( f(x) = 6x + \frac{1}{20}x^5 \).

  Check: \( \square \)

- **Chris** guesses that \( f(x) = x^5 \).

  Check: \( \square \)

- **Dani** guesses that \( f(x) = \frac{1}{20}x^5 \).

  Check: \( \square \)

b. Which of the four students are correct? Select all that apply.

- [ ] Alice
- [ ] Bob
- [ ] Chris
- [ ] Dani
Suppose the second derivative of a function is given as
\[ \frac{d^2f}{dx^2} = e^{-x/3} \]

a. Four students guess what the original function \( f \) is. Find the second derivative of each student's guess to check them.

- **Alice** guesses that \( f(x) = 9e^{-x/3} \).
- **Bob** guesses that \( f(x) = 9e^{-x/3} + 9x \).
- **Chris** guesses that \( f(x) = 9e^{-x/3} + C \) where \( C \) is an unknown constant.
- **Dani** guesses that \( f(x) = 9e^{-x/3} + Cx + D \) where \( C \) and \( D \) are unknown constants.

b. Which of the four students are correct? Select all that apply.

- [ ] Alice
- [ ] Bob
- [ ] Chris
- [ ] Dani
16. Question Details
Suppose the second derivative of a function is given as
\[
\frac{d^2f}{dx^2} = 6x^2
\]
Find any possible function that satisfies the above.
\[
f(x) = \_\_\_
\]

17. Question Details
Suppose the second derivative of a function is given as
\[
\frac{d^2f}{dx^2} = -15\cos(3x)
\]
Find any possible function that satisfies the above.
\[
f(x) = \_\_\_
\]

18. Question Details
Suppose the second derivative of a function is given as
\[
\frac{d^2f}{dx^2} = 10e^{-x/2}
\]
Find any possible function that satisfies the above.
\[
f(x) = \_\_\_
\]
Suppose the second derivative of a function is given as 
\[ \frac{d^2f}{dx^2} = \frac{5}{x^2} \]
Find any possible function that satisfies the above.
\[ f(x) = \]