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((GENERAL MATHEMATICS))

1st stage

Week 8- lecture 8

Exponential functions and logarithms

الدوال الأسية واللوغاريتمات

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Exponential Functions and Logarithms

Exponential functions and logarithms are fundamental concepts in calculus, frequently used in mathematics, engineering, and sciences.

Exponential Functions:-

An exponential function is of the form:

$$f(x) = a \cdot e^{kx}$$

Where:

- e is the base of natural logarithms ($e \approx 2.718e$),
- a and k are constants.

Properties:-

1. The derivative of e^x :

$$\frac{d}{dx}e^x = e^x$$

2. The derivative of e^{kx} :

$$\frac{d}{dx}e^{kx} = k \cdot e^{kx}$$

3. The derivative of a^x :

If $a > 0$, then:

$$\frac{d}{dx}a^x = a^x \ln(a)$$



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Examples:

1. Find the derivative of $f(x) = e^x$:

$$f'(x) = e^x$$

2. Find the derivative of $f(x) = 3e^{2x}$:

$$f'(x) = 6e^{2x}$$

3. Find the derivative of $f(x) = 5^x$:

$$f'(x) = 5^x \ln(5)$$

4. Find the derivative of $f(x) = e^{x^2}$:

Use the chain rule:

$$f'(x) = 2x \cdot e^{x^2}$$

Additional Examples:

1. Find the derivative of $f(x) = e^{x+2}$:

$$f'(x) = e^{x+2}$$

2. Find the derivative of $f(x) = 4e^x$:

$$f'(x) = 4e^x$$

3. Find the derivative of $f(x) = e^{-x}$:

$$f'(x) = -e^{-x}$$

4. Find the derivative of $f(x) = e^{2x+3}$:

$$f'(x) = 2e^{2x+3}$$



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Logarithmic Functions:-

A logarithmic function is of the form:

$$f(x) = \log_a x$$

Where:

- $a > 0$, $a \neq 1$, is the base of the logarithm.
- $\ln(x)$ is the natural logarithm, where $a = e$

Properties:-

1. The derivative of $\ln(x)$:

$$\frac{d}{dx} \ln(x) = \frac{1}{x}, x > 0$$

2. The derivative of $\log_a(x)$:

$$\frac{d}{dx} \log_a(x) = \frac{1}{x \ln(a)}, x > 0$$

3. The derivative of $\ln(g(x))$:

Use the chain rule:

$$\frac{d}{dx} \ln(g(x)) = \frac{g'(x)}{g(x)}$$



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Examples:

1. Find the derivative of $f(x) = \ln(x)$:

$$f'(x) = \frac{1}{x}$$

2. Find the derivative of $f(x) = \ln(3x)$:

Use the chain rule:

$$f'(x) = \frac{1}{3x} \cdot 3 = \frac{1}{x}$$

3. Find the derivative of $f(x) = \log_2(x)$:

$$f'(x) = \frac{1}{x \ln(2)}$$

4. Find the derivative of $f(x) = \ln(x^2 + 1)$:

Use the chain rule:

$$f'(x) = \frac{2x}{x^2 + 1}$$

5. Find the derivative of $f(x) = \ln(5x)$:

$$f'(x) = \frac{1}{x}$$

6. Find the derivative of $f(x) = \ln(x + 1)$:

$$f'(x) = \frac{1}{x + 1}$$

7. Find the derivative of $f(x) = 2 \ln(x)$:

$$f'(x) = \frac{2}{x}$$

8. Find the derivative of $f(x) = \ln(x^3)$:

$$f'(x) = \frac{3}{x}$$