

Learning outcomes

After completing this section, you will inshaAllah be able to

1. know **basic rules** for differentiation
2. know and **use the power rule formula** for differentiation
3. find **derivatives of functions involving exponential function** e^x
4. apply derivatives to **study tangent lines**

How do we find derivatives practically?

By a combination of rules and formulas

Rules set # 1

- $\frac{d}{dx}(c) = 0$
- $\frac{d}{dx}(c \cdot f(x)) = c \cdot \frac{d}{dx}(f(x))$
- $\frac{d}{dx}(f(x) \pm g(x)) = \frac{d}{dx}(f(x)) \pm \frac{d}{dx}(g(x))$

The power rule formula: 1st important formula

$$\frac{d}{dx} x^n = nx^{n-1}$$

True for any 'n'

We will see better use of these formulas in later sections.

Derivatives of functions involving e^x

Differentiation formula for e^x

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

See examples 1, 2, 3 done in class

Application: Slopes and tangent lines

- Recall the following facts from Chapter 2.

- **Slope of a curve at a point = slope of tangent line at that point**

- Slope of tangent line to curve $y = f(x)$ at (x_0, y_0)

is given by $\frac{dy}{dx}$ at (x_0, y_0) .

See examples 4, 5, 6, 7, 8, 9 done in class

Higher order derivatives: Introduction & Computations

- Given a function $f(x)$.
- Then its derivative $f'(x)$ is again a function of x
- So we can differentiate $f'(x)$ further.
- This leads to the idea of higher order derivatives of $f(x)$.

- Given $f(x)$. Then

- $f'(x) = \frac{d}{dx}(f(x))$ 1st derivative of $f(x)$

- $f''(x) = \frac{d}{dx}(f'(x))$ 2nd derivative of $f(x)$

- $f'''(x) = \frac{d}{dx}(f''(x))$ 3rd derivative of $f(x)$

⋮

- $f^{(k)}(x) = \frac{d}{dx}(f^{(k-1)}(x))$ kth derivative of $f(x)$

Other notations

- $y', y'', \dots, y^{(k)}$
- $\frac{dy}{dx}, \frac{d^2y}{dx^2}, \frac{d^3y}{dx^3}, \dots$
- D, D^2, D^3, \dots

See examples 10, 11 done in class

End of 3.1