Section 3.1 *Derivatives of polynomials and exponential functions*

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

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

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

Usually useful when

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
- $f'(x) = \frac{d}{dx}\left(f(x)\right)$ — 1st derivative of $f(x)$
- $f''(x) = \frac{d}{dx}\left(f'(x)\right)$ — 2nd derivative of $f(x)$
- $f'''(x) = \frac{d}{dx}\left(f''(x)\right)$ — 3rd derivative of $f(x)$

$\vdots$

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

Other notations

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

See examples 10, 11 done in class

End of 3.1