3. Differentiation Formulae

(A) $\lim_{\theta \to 0} \left(\frac{\sin \theta}{\theta} \right) = 1,$ $\lim_{n \to \infty} \left(1 + \frac{1}{n} \right)^n = e,$

$\lim_{y \to 0} (1 + y)^{1/y} = e,$ $\lim_{x \to 0} \frac{a^x - 1}{x} = \log_e a.$

(B) **1.** If $y = x^n$, $\frac{dy}{dx} = n x^{n-1}$

2. If $y = \sin x$, $\frac{dy}{dx} = \cos x$

3. If $y = \cos x$, $\frac{dy}{dx} = -\sin x$

4. If $y = \tan x$, $\frac{dy}{dx} = \sec^2 x$

5. If $y = \text{cosec } x$, $\frac{dy}{dx} = -\text{cosec } x \cot x$

6. If $y = \sec x$, $\frac{dy}{dx} = \sec x \tan x$

7. If $y = \cot x$, $\frac{dy}{dx} = -\text{cosec}^2 x$

8. If $y = e^x$, $\frac{dy}{dx} = e^x$

9. If $y = a^x$, $\frac{dy}{dx} = a^x \log a$

10. If $y = \log_e x$, $\frac{dy}{dx} = \frac{1}{x}$

11. If $y = \log_a x$, $\frac{dy}{dx} = \frac{1}{x \log a}$

12. If $y = \sin^{-1} x$, $\frac{dy}{dx} = \frac{1}{\sqrt{1 - x^2}}$

13. If $y = \cos^{-1} x$, $\frac{dy}{dx} = -\frac{1}{\sqrt{1 - x^2}}$

14. If $y = \tan^{-1} x$, $\frac{dy}{dx} = \frac{1}{1 + x^2}$

15. If $y = \sec^{-1} x$, $\frac{dy}{dx} = \frac{1}{x\sqrt{x^2 - 1}}$

16. If $y = \text{cosec}^{-1} x$, $\quad \dfrac{dy}{dx} = -\dfrac{1}{x\sqrt{x^2-1}}$

17. If $y = \cot^{-1} x$, $\quad \dfrac{dy}{dx} = -\dfrac{1}{1+x^2}$

18. If $y = \sin hx$, $\quad \dfrac{dy}{dx} = \cos h\, x$

19. If $y = \cos hx$, $\quad \dfrac{dy}{dx} = \sin h\, x$

20. If $y = \tan hx$, $\quad \dfrac{dy}{dx} = \sec h^2 x$

21. If $y = \text{cosec}\, hx$, $\quad \dfrac{dy}{dx} = -\text{cosec}\, h\, x \cot x$

22. If $y = \sec hx$, $\quad \dfrac{dy}{dx} = \sec h\, x \tan h\, x$

23. If $y = \cot hx$, $\quad \dfrac{dy}{dx} = -\text{cosec}\, h^2 x$

24. If $y = \sin h^{-1} x$, $\quad \dfrac{dy}{dx} = \dfrac{1}{\sqrt{1+x^2}}$

25. If $y = \cos h^{-1} x$, $\quad \dfrac{dy}{dx} = \dfrac{1}{\sqrt{x^2-1}}$

26. If $y = \tan h^{-1} x$, $\quad \dfrac{dy}{dx} = \dfrac{1}{1-x^2}$

27. If $y = \sec h^{-1} x$, $\quad \dfrac{dy}{dx} = -\dfrac{1}{x\sqrt{1-x^2}}$

28. If $y = \text{cosec}\, h^{-1} x$, $\quad \dfrac{dy}{dx} = -\dfrac{1}{|x|\sqrt{1+x^2}}$

29. If $y = \cot h^{-1} x$, $\quad \dfrac{dy}{dx} = \dfrac{1}{1-x^2}$

(C) 1. If $y = u \pm v$, $\quad \dfrac{dy}{dx} = \dfrac{du}{dx} \pm \dfrac{dv}{dx}$

2. If $y = uv$, $\quad \dfrac{dy}{dx} = v\dfrac{du}{dx} + u\dfrac{dv}{dx}$

3. If $y = \dfrac{u}{v}$, $\quad \dfrac{dy}{dx} = \dfrac{v\dfrac{du}{dx} - u\dfrac{dv}{dx}}{v^2}$

4. If $y = x^x$, $\quad \dfrac{dy}{dx} = x^x (1 + \log x)$

5. If $x = f(t)$, $y = \Phi(t)$, $\quad \dfrac{dy}{dx} = \dfrac{dy/dt}{dx/dt}$