

LIST OF NECESSARY FORMULAS FOR DIFFERENTIATION:

$$\begin{aligned}
 \frac{d}{dx}(x) &= 1 \\
 \frac{d}{dx}(ax) &= a \\
 \frac{d}{dx}(x^n) &= nx^{n-1} \\
 \frac{d}{dx}(\sin(x)) &= \cos(x) \\
 \frac{d}{dx}(\cos(x)) &= -\sin(x) \\
 \frac{d}{dx}(\tan(x)) &= \sec^2(x) \\
 \frac{d}{dx}(\cot(x)) &= -\operatorname{cosec}^2(x) \\
 \frac{d}{dx}(\sec(x)) &= \sec x \tan(x) \\
 \frac{d}{dx}(\operatorname{cosec}(x)) &= -\operatorname{cosec}(x) \cot(x) \\
 \frac{d}{dx}(\ln(x)) &= \frac{1}{x} \\
 \frac{d}{dx}(\ln(mx)) &= m \frac{1}{mx} = \frac{1}{x} \\
 \frac{d}{dx}(\sin(mx)) &= m \cos(mx) \\
 \frac{d}{dx}(\cos(mx)) &= -m \sin(mx) \\
 \frac{d}{dx}(\sin^2(x)) &= \frac{d}{dx}(\sin(x))^2 = 2\sin(x)(\cos(x)) = 2\sin(x)\cos(x) = \sin(2x) \\
 \frac{d}{dx}(\cos^2(x)) &= \frac{d}{dx}(\cos(x))^2 = 2\cos(x)(-\sin(x)) = -2\sin(x)\cos(x) = -\sin(2x) \\
 \frac{d}{dx}(e^x) &= e^x \\
 \frac{d}{dx}(e^{mx}) &= me^{mx} \\
 \frac{d}{dx}(a^x) &= a^x \ln a
 \end{aligned}$$

The SUM Rule:

$$\frac{d}{dx}(u + v) = \frac{d}{dx}u + \frac{d}{dx}v$$

Example:

$$\begin{aligned}
 &\frac{d}{dx}(x^2 + 2x + 3) \\
 &= \frac{d}{dx}(x^2) + \frac{d}{dx}(2x) + \frac{d}{dx}(3) \\
 &= 2x + 1
 \end{aligned}$$

The PRODUCT Rule:

$$\frac{d}{dx}(uv) = u \frac{d}{dx}v + v \frac{d}{dx}u$$

Example:

$$\begin{aligned}
 &\frac{d}{dx}(x^2 \cos(x)) \\
 &= x^2 \frac{d}{dx}(\cos(x)) + \cos(x) \frac{d}{dx}(x^2) \\
 &= x^2(-\sin(x)) + 2x(\cos(x))
 \end{aligned}$$

The QUOTIENT Rule:

$$\frac{d}{dx}\left(\frac{u}{v}\right) = \frac{v \frac{d}{dx}(u) - u \frac{d}{dx}(v)}{v^2}$$

Example:

$$\begin{aligned}
 &\frac{d}{dx}\left(\frac{x^3}{x+4}\right) \\
 &= \frac{(x+4) \frac{d}{dx}(x^3) - x^3 \frac{d}{dx}(x+4)}{(x+4)^2} \\
 &= \frac{(x+4)(3x^2) - x^3(1)}{(x+4)^2} \\
 &= \frac{2x^3 + 12x^2}{(x+4)^2}
 \end{aligned}$$