I. Fundamental or Basic Identities

A. Reciprocal Identities

$$\csc\theta = \frac{1}{\sin\theta} \qquad \sec\theta = \frac{1}{\cos\theta} \qquad \cot\theta = \frac{1}{\tan\theta}$$

B. Quotient Identities

$$\tan\theta = \frac{\sin\theta}{\cos\theta} \qquad \cot\theta = \frac{\cos\theta}{\sin\theta}$$

C. Pythagorean Identities

$$\sin^2\theta + \cos^2\theta = 1 \qquad \tan^2\theta + 1 = \sec^2\theta \qquad \cot^2\theta + 1 = \csc^2\theta$$

II. Identities for Negatives

$$\sin(-\theta) = -\sin\theta \qquad \cos(-\theta) = \cos\theta \qquad \tan(-\theta) = -\tan\theta$$

III. Co - function Identities

$$\sin(90^0 \pm \theta) = \cos\theta \qquad \sin(\theta \pm 90^0) = \pm\cos\theta$$

$$\cos(90^0 \pm \theta) = \mp\sin\theta \qquad \cos(\theta \pm 90^0) = \mp\sin\theta$$

IV. Sum and Difference Identities

$$\sin(\alpha \pm \beta) = \sin\alpha\cos\beta \pm \cos\alpha\sin\beta \qquad \tan(\alpha \pm B) = \frac{\tan\alpha \pm \tan\beta}{1 \mp \tan\alpha\tan\beta}$$

$$\cos(\alpha \pm \beta) = \cos\alpha\cos\beta \mp \sin\alpha\sin\beta$$

V. Double - Angle Identities

$$\sin 2\theta = 2\sin\theta\cos\theta$$

$$\cos 2\theta = \cos^2\theta - \sin^2\theta = 1 - 2\sin^2\theta = 2\cos^2\theta - 1$$

$$\tan 2\theta = \frac{2\tan\theta}{1-\tan^2\theta}$$

$$\sin^2\theta = \frac{1-\cos 2\theta}{2} \qquad \cos^2\theta = \frac{1+\cos 2\theta}{2}$$

VI. Half - Angle Identities

$$\sin\frac{1}{2}\theta = \pm\sqrt{\frac{1-\cos\theta}{2}} \qquad \cos\frac{1}{2}\theta = \pm\sqrt{\frac{1+\cos\theta}{2}}$$

$$\tan\frac{1}{2}\theta = \pm\sqrt{\frac{1-\cos\theta}{1+\cos\theta}} = \frac{\sin\theta}{1+\cos\theta} = \frac{1-\cos\theta}{\sin\theta}$$

Summary of Formula

Derivative of a Function by Formula / Rules for Differentiation

1. The Constant Rule $\frac{d}{dx}(c) = 0$
2. The Identity Function Rule $\frac{d}{dx}(x) = 1$
3. The Constant & a Function Rule $\frac{d}{dx}(cu) = c\frac{du}{dx}$
4. The Sum / Difference Rule $d(u+v) = du + dv \quad d(u-v) = du - dv$
5. The Product Rule $d(uv) = udv + vdu$
6. The Quotient Rule $d\left(\frac{u}{v}\right) = \frac{vdu - udv}{v^2}$
7. The Power Rule / Formula $d(u^n) = nu^{n-1}du$
8. Chain Rule $\frac{dy}{dx} = \frac{dy}{du} \bullet \frac{du}{dx}$
9. Inverse Function Rule $\frac{dy}{dx} = \frac{1}{\frac{dx}{dy}}$, where $\frac{dx}{dy} \neq 0$
10. Parametric Function Rule $\frac{dy}{dx} = \frac{\frac{dy}{du}}{\frac{dx}{du}}$, where $\frac{dx}{du} \neq 0$
11. Higher Parametric Function Rule $\frac{d^2y}{dx^2} = \frac{1}{\frac{dx}{du}}\left[\frac{d}{du}\left(\frac{dy}{dx}\right)\right]$

Derivative of Trigonometric Functions

1. $\frac{d}{dx}(\sin u) = \cos u\frac{du}{dx}$
2. $\frac{d}{dx}(\cos u) = -\sin u\frac{du}{dx}$
3. $\frac{d}{dx}(\tan u) = \sec^2 u\frac{du}{dx}$
4. $\frac{d}{dx}(\sec u) = \sec u \tan u\frac{du}{dx}$
5. $\frac{d}{dx}(\csc u) = -\csc u \cot u\frac{du}{dx}$
6. $\frac{d}{dx}(\cot u) = -\csc^2 u\frac{du}{dx}$

Derivative of Inverse Trigonometric Functions

1. $\frac{d}{dx}(\arcsin u) = \frac{1}{\sqrt{1-u^2}}\frac{du}{dx}$
2. $\frac{d}{dx}(\arccos u) = -\frac{1}{\sqrt{1-u^2}}\frac{du}{dx}$
3. $\frac{d}{dx}(\arctan u) = \frac{1}{1+u^2}\frac{du}{dx}$
4. $\frac{d}{dx}(\operatorname{arccot} u) = -\frac{1}{1+u^2}\frac{du}{dx}$
5. $\frac{d}{dx}(\operatorname{arcsec} u) = \frac{1}{u\sqrt{u^2-1}}\frac{du}{dx}$
6. $\frac{d}{dx}(\operatorname{arccsc} u) = -\frac{1}{u\sqrt{u^2-1}}\frac{du}{dx}$

Derivative of Exponential and Logarithmic Functions

1. $\frac{d}{dx}(\ln u) = \frac{1}{u} \bullet \frac{du}{dx}$
2. $\frac{d}{dx}(a^u) = a^u \ln a \frac{du}{dx}$
3. $\frac{d}{dx}(e^u) = e^u \frac{du}{dx}$

Derivative of Hyperbolic Functions

1. $\frac{d}{dx}(\sinh u) = \cosh u \frac{du}{dx}$
2. $\frac{d}{dx}(\cosh u) = \sinh u \frac{du}{dx}$
3. $\frac{d}{dx}(\tanh u) = \operatorname{sech}^2 u \frac{du}{dx}$
4. $\frac{d}{dx}(\operatorname{sech} u) = -\operatorname{sech} u \tanh u \frac{du}{dx}$
5. $\frac{d}{dx}(\operatorname{csch} u) = -\operatorname{csch} u \coth u \frac{du}{dx}$
6. $\frac{d}{dx}(\coth u) = -\operatorname{csch}^2 u \frac{du}{dx}$

Derivative of Inverse Hyperbolic Functions

1. $\frac{d}{dx}(\sinh^{-1} u) = \frac{du/dx}{\sqrt{1+u^2}}$
2. $\frac{d}{dx}(\cosh^{-1} u) = \frac{du/dx}{\sqrt{u^2-1}}$
3. $\frac{d}{dx}(\operatorname{sech}^{-1} u) = \frac{du/dx}{u\sqrt{1-u^2}}$
4. $\frac{d}{dx}(\operatorname{csch}^{-1} u) = \frac{du/dx}{u\sqrt{1+u^2}}$
5. $\frac{d}{dx}(\tanh^{-1} u) = \frac{du/dx}{1-u^2}$ where $-1 < u < 1$
6. $\frac{d}{dx}(\coth^{-1} u) = \frac{du/dx}{1-u^2}$ where $u > 1$ or $u < -1$