

# Formulae Booklet - Essentials

## Trigonometric

$$\sin(A \pm B) = \sin A \cos B \pm \cos A \sin B$$

$$\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$$

$$e^{ix} = \cos(x) + i \sin(x)$$

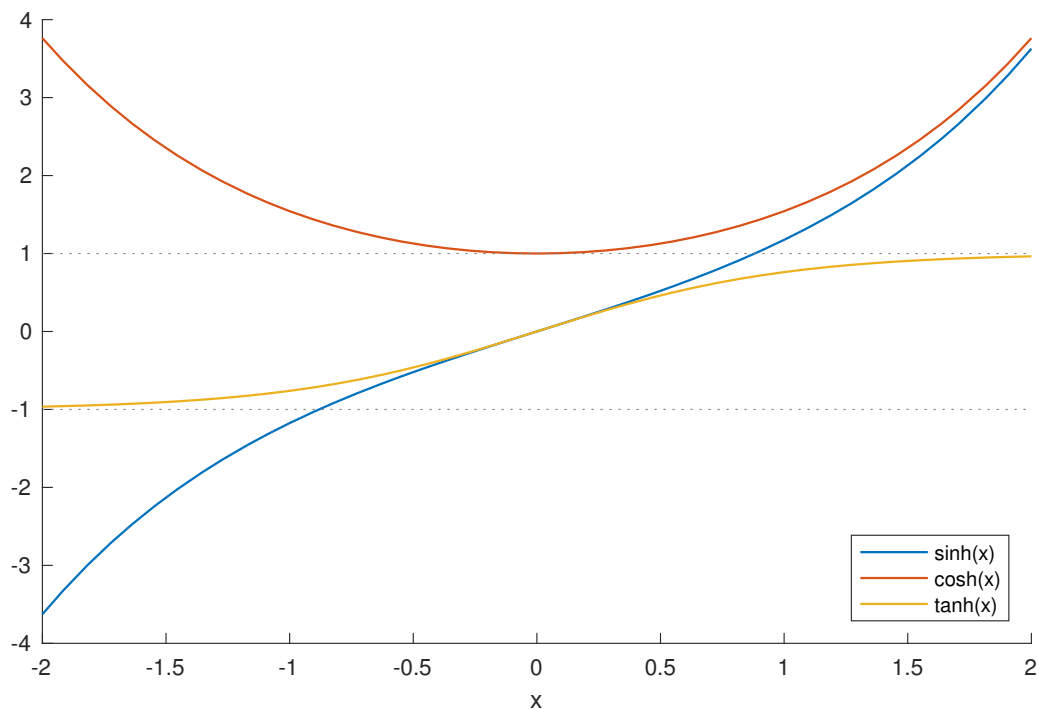
$$\cos x = \frac{e^{ix} + e^{-ix}}{2}, \quad \sin x = \frac{e^{ix} - e^{-ix}}{2i}$$

## Hyperbolic

$$\sinh(A \pm B) = \sinh A \cosh B \pm \cosh A \sinh B$$

$$\cosh(A \pm B) = \cosh A \cosh B \pm \sinh A \sinh B$$

$$\cosh x = \frac{e^x + e^{-x}}{2}, \quad \sinh x = \frac{e^x - e^{-x}}{2}$$



## Quotient rule

$$f(x) = \frac{u(x)}{v(x)} \Rightarrow f'(x) = \frac{vu' - uv'}{v^2}$$

## Integrating factor

$$\frac{dy}{dx} + P(x)y = R(x, y) \Rightarrow I(x) = \exp\left(\int P(x)dx\right)$$

### Residue at n-th order pole at $k = k_0$

$$Res(f, k_0) = \frac{1}{(n-1)!} \lim_{k \rightarrow k_0} \frac{d^{n-1}}{dk^{n-1}} \left( (k - k_0)^n f(k) \right)$$

so for a simple-pole ( $n=1$ ), we have

$$Res(f, k_0) = \lim_{k \rightarrow k_0} (k - k_0) f(k)$$

### Contour integration (with n-th order pole at $k = k_0$ )

$$\int_C f(x) dx = \begin{cases} 2\pi i \times Res(f, k_0) & \text{if } C \text{ counter-clockwise} \\ -2\pi i \times Res(f, k_0) & \text{if } C \text{ clockwise} \end{cases}$$

### Integrals

$$\begin{aligned} \int \frac{a}{a^2 + x^2} dx &= \tan^{-1} \left( \frac{x}{a} \right) \\ \int \frac{1}{\sin x} dx &= \log \left| \tan \left( \frac{x}{2} \right) \right| \\ \int \frac{1}{\cos x} dx &= \log |\sec(x) + \tan(x)| \end{aligned}$$

### Heaviside function

$$H(x) = \begin{cases} 1 & \text{if } x > 0, \\ 0 & \text{if } x < 0. \end{cases}$$

### Dirac delta function

$$\delta(x) = \begin{cases} \infty & \text{if } x = 0, \\ 0 & \text{if } x \neq 0. \end{cases} \quad \text{where} \quad \int_{-\infty}^{\infty} \delta(x) dx = 1$$