Formulae

- *Trigonometric Identities:*

$$e^{\pm jx} = \cos x \pm j\sin x,\ \sin(2x) = 2\ \sin x\ \cos x,\ \cos(2x) = 2\cos^2 x - 1$$

$$\sin(x \pm y) = \sin x\ \cos y \pm \cos x\ \sin y,\ \cos(x \pm y) = \cos x\ \cos y \mp \sin x\ \sin y$$

- *Calculus:*

$$\big(u(x)v(x)\big)' = u(x)v'(x) + u'(x)v(x), \quad \int u(x)v'(x)dx = u(x)v(x) - \int u'(x)v(x)dx$$

- *Convolution:*

$$x(t) * h(t) = \int_{-\infty}^{\infty} x(\tau)h(t-\tau)d\tau = \int_{-\infty}^{\infty} x(t-\tau)h(\tau)d\tau$$

- *Laplace Transform:*

$$X(s) = \int_{-\infty}^{\infty} x(t)e^{-st}dt, \quad x(t) = \frac{1}{2\pi j}\int_{c-j\infty}^{c+j\infty} X(s)e^{st}ds$$

$$\delta(t) \iff 1,\quad u(t) \iff \frac{1}{s},\quad t^n u(t) \iff \frac{n!}{s^{n+1}},\quad e^{at}u(t) \iff \frac{1}{s-a},\quad t^n e^{at}u(t) \iff \frac{n!}{(s-a)^{n+1}}$$

$$(\cos bt)u(t) \iff \frac{s}{s^2+b^2},\quad (\sin bt)u(t) \iff \frac{b}{s^2+b^2},\quad (e^{-at}\cos bt)u(t) \iff \frac{s+a}{(s+a)^2+b^2}$$

$$(e^{-at}\sin bt)u(t) \iff \frac{b}{(s+a)^2+b^2},\quad (re^{-at}\cos(bt+\theta))u(t) \iff \frac{(r\cos\theta)s + (ar\cos\theta - br\sin\theta)}{s^2+2as+(a^2+b^2)}$$

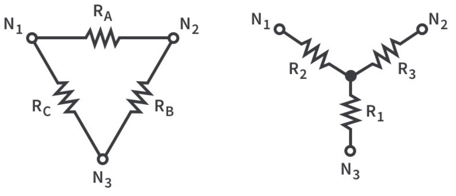
- *Laplace Transform Properties:*

$$x(t) \iff X(s),\ x(t-t_0)u(t-t_0) \iff e^{-st_0}X(s),\ x(t)e^{s_0 t} \iff X(s-s_0),\quad x(at) \iff \frac{1}{a}X\left(\frac{s}{a}\right)$$

$$x_1(t) * x_2(t) \iff X_1(s)\cdot X_2(s),\quad x_1(t)\cdot x_2(t) = \frac{1}{2\pi j}X_1(s) * X_2(s),\quad -tx(t) \iff \frac{dX(s)}{ds}$$

$$\frac{d^n x}{dt^n} \iff s^n X(s) - \sum_{k=1}^{n} s^{n-k}x^{(k-1)}(0^-),\quad \int_{-\infty}^{t} x(\tau)d\tau \iff \frac{X(s)}{s} + \frac{1}{s}\int_{-\infty}^{0^-} x(t)dt,\quad \frac{x(t)}{t} \iff \int_{s}^{\infty} X(z)dz$$

$$\text{IVT: } x(0^+) = \lim_{s\to\infty} sX(s)\ (n > m),\quad \text{FVT: } x(\infty) = \lim_{s\to 0} sX(s)\ \text{(poles of X(s) in LHP)}$$



$$R_A = \frac{R_1R_2+R_2R_3+R_3R_1}{R_1} \qquad R_1 = \frac{R_BR_C}{R_A+R_B+R_C}$$

$$R_B = \frac{R_1R_2+R_2R_3+R_3R_1}{R_2} \qquad R_2 = \frac{R_CR_A}{R_A+R_B+R_C}$$

$$R_C = \frac{R_1R_2+R_2R_3+R_3R_1}{R_3} \qquad R_3 = \frac{R_AR_B}{R_A+R_B+R_C}$$

	z	**y**	**T**	**h**
z	$\begin{bmatrix} \mathbf{z}_{11} & \mathbf{z}_{12} \\ \mathbf{z}_{21} & \mathbf{z}_{22} \end{bmatrix}$	$\begin{bmatrix} \frac{\mathbf{y}_{22}}{\Delta\mathbf{y}} & \frac{-\mathbf{y}_{12}}{\Delta\mathbf{y}} \\ \frac{-\mathbf{y}_{21}}{\Delta\mathbf{y}} & \frac{\mathbf{y}_{11}}{\Delta\mathbf{y}} \end{bmatrix}$	$\begin{bmatrix} \frac{\mathbf{A}}{\mathbf{C}} & \frac{\Delta\mathbf{T}}{\mathbf{C}} \\ \frac{1}{\mathbf{C}} & \frac{\mathbf{D}}{\mathbf{C}} \end{bmatrix}$	$\begin{bmatrix} \frac{\Delta\mathbf{h}}{\mathbf{h}_{22}} & \frac{\mathbf{h}_{12}}{\mathbf{h}_{22}} \\ \frac{-\mathbf{h}_{21}}{\mathbf{h}_{22}} & \frac{1}{\mathbf{h}_{22}} \end{bmatrix}$
y	$\begin{bmatrix} \frac{\mathbf{z}_{22}}{\Delta\mathbf{z}} & \frac{-\mathbf{z}_{12}}{\Delta\mathbf{z}} \\ \frac{-\mathbf{z}_{21}}{\Delta\mathbf{z}} & \frac{\mathbf{z}_{11}}{\Delta\mathbf{z}} \end{bmatrix}$	$\begin{bmatrix} \mathbf{y}_{11} & \mathbf{y}_{12} \\ \mathbf{y}_{21} & \mathbf{y}_{22} \end{bmatrix}$	$\begin{bmatrix} \frac{\mathbf{D}}{\mathbf{B}} & \frac{-\Delta\mathbf{T}}{\mathbf{B}} \\ \frac{-1}{\mathbf{B}} & \frac{\mathbf{A}}{\mathbf{B}} \end{bmatrix}$	$\begin{bmatrix} \frac{1}{\mathbf{h}_{11}} & \frac{-\mathbf{h}_{22}}{\mathbf{h}_{11}} \\ \frac{\mathbf{h}_{21}}{\mathbf{h}_{11}} & \frac{\Delta\mathbf{h}}{\mathbf{h}_{11}} \end{bmatrix}$
T	$\begin{bmatrix} \frac{\mathbf{z}_{11}}{\mathbf{z}_{21}} & \frac{\Delta\mathbf{z}}{\mathbf{z}_{21}} \\ \frac{1}{\mathbf{z}_{21}} & \frac{\mathbf{z}_{22}}{\mathbf{z}_{21}} \end{bmatrix}$	$\begin{bmatrix} \frac{-\mathbf{y}_{22}}{\mathbf{y}_{21}} & \frac{-1}{\mathbf{y}_{21}} \\ \frac{-\Delta\mathbf{y}}{\mathbf{y}_{21}} & \frac{-\mathbf{y}_{11}}{\mathbf{y}_{21}} \end{bmatrix}$	$\begin{bmatrix} \mathbf{A} & \mathbf{B} \\ \mathbf{C} & \mathbf{D} \end{bmatrix}$	$\begin{bmatrix} \frac{-\Delta\mathbf{h}}{\mathbf{h}_{21}} & \frac{-\mathbf{h}_{11}}{\mathbf{h}_{21}} \\ \frac{-\mathbf{h}_{22}}{\mathbf{h}_{21}} & \frac{-1}{\mathbf{h}_{21}} \end{bmatrix}$
h	$\begin{bmatrix} \frac{\Delta\mathbf{z}}{\mathbf{z}_{22}} & \frac{\mathbf{z}_{12}}{\mathbf{z}_{22}} \\ \frac{-\mathbf{z}_{21}}{\mathbf{z}_{22}} & \frac{1}{\mathbf{z}_{22}} \end{bmatrix}$	$\begin{bmatrix} \frac{1}{\mathbf{y}_{11}} & \frac{-\mathbf{y}_{12}}{\mathbf{y}_{11}} \\ \frac{\mathbf{y}_{21}}{\mathbf{y}_{11}} & \frac{\Delta\mathbf{y}}{\mathbf{y}_{11}} \end{bmatrix}$	$\begin{bmatrix} \frac{\mathbf{B}}{\mathbf{D}} & \frac{\Delta\mathbf{T}}{\mathbf{D}} \\ -\frac{1}{\mathbf{D}} & \frac{\mathbf{C}}{\mathbf{D}} \end{bmatrix}$	$\begin{bmatrix} \mathbf{h}_{11} & \mathbf{h}_{12} \\ \mathbf{h}_{21} & \mathbf{h}_{22} \end{bmatrix}$

$$\Delta\mathbf{z} = \mathbf{z}_{11}\mathbf{z}_{22} - \mathbf{z}_{12}\mathbf{z}_{21}, \Delta\mathbf{y} = \mathbf{y}_{11}\mathbf{y}_{22} - \mathbf{y}_{12}\mathbf{y}_{21}, \Delta\mathbf{h} = \mathbf{h}_{11}\mathbf{h}_{22} - \mathbf{h}_{12}\mathbf{h}_{21}, \Delta\mathbf{T} = \mathbf{AD} - \mathbf{BC}$$