- *Trigonometric Identities:*

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

- *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:*

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

- *Trignometric Fourier Series:*

$$x(t) = a_0 + \sum_{n=1}^{\infty} a_n \cos(n\omega_0 t) + \sum_{n=1}^{\infty} b_n \sin(n\omega_0 t)$$

$$a_0 = \frac{1}{T_0}\int_{T_0} x(t)dt,\quad a_n = \frac{2}{T_0}\int_{T_0} x(t)\cos(n\omega_0 t)dt,\quad b_n = \frac{2}{T_0}\int_{T_0} x(t)\sin(n\omega_0 t)dt$$

- *Compact Trignometric Fourier Series:*

$$x(t) = C_0 + \sum_{n=1}^{\infty} C_n \cos(n\omega_0 t + \theta_n),\quad C_0 = a_0,\quad C_n = \sqrt{a_n^2 + b_n^2},\quad \theta_n = \tan^{-1}(-b_n/a_n)$$

- *Exponential Fourier Series:*

$$x(t) = \sum_{n=-\infty}^{\infty} D_n e^{jn\omega_0 t},\quad D_n = \frac{1}{T_0}\int_{T_0} x(t)e^{-jn\omega_0 t}dt$$

- *Fourier Series Properties:*

$$x(t) \iff D_n,\ kx(t) \iff kD_n,\ x(-t) \iff D_{-n}$$

$$x(t-t_0) \iff D_n e^{-jn\omega_0 t_0},\ x(t)e^{jn_0\omega_0 t} \iff D_{n-n_0},\ x^*(t) \iff D_{-n}^*$$

- *Fourier Transform:*

$$X(\omega) = \int_{-\infty}^{\infty} x(t)e^{-j\omega t}dt,\quad x(t) = \frac{1}{2\pi}\int_{-\infty}^{\infty} X(\omega)e^{j\omega t}d\omega$$

$$\delta(t) \iff 1,\quad 1 \iff 2\pi\delta(\omega),\quad u(t) \iff \pi\delta(\omega) + \frac{1}{j\omega},\ e^{j\omega_0 t} \iff 2\pi\delta(\omega - \omega_0)$$

$$\mathrm{rect}\Big(\frac{t}{\tau}\Big) \iff \tau\mathrm{sinc}\Big(\frac{\omega\tau}{2}\Big),\ \triangle\Big(\frac{t}{\tau}\Big) \iff \frac{\tau}{2}\mathrm{sinc}^2\Big(\frac{\omega\tau}{4}\Big),\ \sum_{n=-\infty}^{\infty}\delta(t - nT_0) = \frac{2\pi}{T_0}\sum_{n=-\infty}^{\infty}\delta\Big(\omega - \frac{2\pi n}{T_0}\Big)$$

- *Fourier Transform Properties:*

$$x(t) \iff X(\omega),\ x(t-t_0) \iff e^{-j\omega t_0}X(\omega),\ x(t)e^{j\omega_0 t} \iff X(\omega - \omega_0)$$

$$X(t) \iff 2\pi x(-\omega),\ x(at) \iff \frac{1}{|a|}X\Big(\frac{\omega}{a}\Big),\ x^*(t) \iff X^*(-\omega),\ \frac{d^n x}{dt^n} \iff (j\omega)^n X(\omega)$$

$$\int_{-\infty}^{t} x(\tau)d\tau \iff \pi X(0)\delta(\omega) + \frac{X(\omega)}{j\omega},\ x_1(t) * x_2(t) \iff X_1(\omega)\cdot X_2(\omega),\ x_1(t)\cdot x_2(t) = \frac{1}{2\pi}X_1(\omega) * X_2(\omega)$$

- *Parseval's Theorem:*

$$P_x = \frac{1}{T_0}\int_{T_0}|x(t)|^2 dt \ = \ a_0^2 + \frac{1}{2}\sum_{n=1}^{\infty}(a_n^2 + b_n^2) \ = \ C_0^2 + \frac{1}{2}\sum_{n=1}^{\infty} C_n^2 \ = \sum_{n=-\infty}^{\infty}|D_n|^2$$

$$E_x = \int_{-\infty}^{\infty}|x(t)|^2 dt \ = \frac{1}{2\pi}\int_{-\infty}^{\infty}|X(\omega)|^2 d\omega$$