

$$* \text{Even } \{f(t)\} = \frac{1}{2} \{f(t) + f(-t)\} \quad * \cos \omega_0 t = \frac{e^{j\omega_0 t} + e^{-j\omega_0 t}}{2} \quad * \delta[n] = \begin{cases} 1, & n=0 \\ 0, & \text{otherwise} \end{cases}$$

$$* \text{Odd } \{f(t)\} = \frac{1}{2} \{f(t) - f(-t)\} \quad * \sin \omega_0 t = \frac{e^{j\omega_0 t} - e^{-j\omega_0 t}}{2j} \quad * u[n] = \begin{cases} 1, & n \geq 0 \\ 0, & n < 0 \end{cases}$$

$$* x[n] = x[n+N]; \quad N = \frac{2\pi}{|\omega_0|}$$

$$* \delta[n] = u[n] - u[n-1]$$

$$* u[n] = \sum_{m=-\infty}^n \delta[m]$$

$$* \delta(t) = \frac{du(t)}{dt}$$

$$* u(t) = \int_{-\infty}^t \delta(\tau) d\tau$$

$$* \delta[n-k] \rightarrow \boxed{\text{LTI}} \rightarrow h[n-k]$$

$$* x[n] * h[n] = y[n] = \sum_{k=-\infty}^{\infty} x[k] h[n-k]$$

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

$$- x[n] * h[n] = h[n] * x[n]$$

$$- x[n] * (h_1[n] + h_2[n]) = x[n] * h_1[n] + x[n] * h_2[n]$$

$$- x[n] * (h_1[n] * h_2[n]) = (x[n] * h_1[n]) * h_2[n]$$

$$y(t) = \sum_{k=-\infty}^{\infty} a_k H(e^{jk\omega_0 t}) e^{jk\omega_0 t}$$

$$* x(t) = \sum_{k=-\infty}^{\infty} a_k e^{jk\omega_0 t}; \quad \omega_0 = \frac{2\pi}{T}$$

$$* a_k = \frac{1}{T} \int_T x(t) e^{-jk\omega_0 t} dt$$

$$* x(t) \xleftrightarrow{\text{FS}} a_k$$

$$y(t) \xleftrightarrow{\text{FS}} b_k$$

$$A x(t) + B y(t) \xleftrightarrow{\text{FS}} A a_k + B b_k$$

$$x(t-t_0) \xleftrightarrow{\text{FS}} e^{-jk\omega_0 t_0} a_k$$

$$x(-t) \xleftrightarrow{\text{FS}} a_{-k}$$

$$x(\alpha t) \xleftrightarrow{\text{FS}} \frac{1}{|\alpha|} \sum_{k=-\infty}^{\infty} x(\alpha t) e^{-jk(\alpha\omega_0)t} dt$$

$$x(t) y(t) \xleftrightarrow{\text{FS}} \sum_{l=-\infty}^{\infty} a_l b_{k-l} = a_k * b_k$$

$$* x(t) \xleftrightarrow{\text{FS}} a_{-k}^*$$

$$* \frac{1}{T} \int_T |x(t)|^2 dt = \sum_{k=-\infty}^{\infty} |a_k|^2$$

$$* x[n] = \sum_{k=-\infty}^{\infty} a_k e^{jk\frac{2\pi}{N}n}$$

$$* a_k = \frac{1}{N} \sum_{n=-\infty}^{\infty} x[n] e^{-jk\frac{2\pi}{N}n}; \quad a_k = a_{k+N}$$

$$* x[n] \xleftrightarrow{\text{FS}} a_k$$

$$y[n] \xleftrightarrow{\text{FS}} b_k$$

$$A x[n] + B y[n] \xleftrightarrow{\text{FS}} A a_k + B b_k$$

$$x[n-n_0] \xleftrightarrow{\text{FS}} a_k e^{-jk\frac{2\pi}{N}n_0}$$

$$x[-n] \xleftrightarrow{\text{FS}} a_{-k}$$

$$x[mn] \xleftrightarrow{\text{FS}} \frac{1}{m} a_k; \quad N_2 = mN$$

$$x[n] y[n] \xleftrightarrow{\text{FS}} \sum_{l=-\infty}^{\infty} a_l b_{k-l}$$

$$x^*[n] \xleftrightarrow{\text{FS}} a_{-k}^*$$

$$e^{jm\frac{2\pi}{N}n} x[n] \xleftrightarrow{\text{FS}} a_{k-m}$$

$$* \frac{1}{N} \sum_{k=-\infty}^{\infty} |x[n]|^2 = \sum_{k=-\infty}^{\infty} |a_k|^2$$

$$* \sum_{r=-\infty}^{\infty} x[r] y[r-r] \xleftrightarrow{\text{FS}} N a_k b_k$$

$$* X(j\omega) = \int_{-\infty}^{\infty} x(t) e^{-j\omega t} dt$$

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

$$* t x(t) \xleftrightarrow{\text{FT}} j \frac{d}{d\omega} X(j\omega)$$

$$* a x(t) + b y(t) \xleftrightarrow{\text{FT}} a X(j\omega) + b Y(j\omega)$$

$$* x(t-t_0) \xleftrightarrow{\text{FT}} X(j\omega) e^{-j\omega t_0}$$

$$* x^*(t) \xleftrightarrow{\text{FT}} X^*(-j\omega)$$

$$* \frac{d}{dt} x(t) \xleftrightarrow{\text{FT}} j\omega X(j\omega)$$

$$* x(t) y(t) \xleftrightarrow{\text{FT}} \frac{1}{2\pi} \int_{-\infty}^{\infty} X(j\omega) Y(j(\omega-\theta)) d\theta$$

$$* X(\alpha t) \xleftrightarrow{\text{FT}} \frac{1}{|\alpha|} X(j\frac{\omega}{\alpha})$$

$$* e^{j\omega_0 t} x(t) \xleftrightarrow{\text{FT}} X(j(\omega-\omega_0))$$

$$* x(t) * y(t) \xleftrightarrow{\text{FT}} X(j\omega) Y(j\omega)$$

$$* \int_{-\infty}^{\infty} x(\tau) d\tau \xleftrightarrow{\text{FT}} \frac{1}{j\omega} X(j\omega) + \pi x(0) \delta(\omega)$$

$$* X(e^{j\omega}) = \sum_{n=-\infty}^{\infty} x[n] e^{-j\omega n}$$

$$* x[n] = \frac{1}{2\pi} \int_{-\pi}^{\pi} X(e^{j\omega}) e^{j\omega n} d\omega$$

$$* n x[n] \xleftrightarrow{\text{FT}} j \frac{d}{d\omega} X(e^{j\omega})$$

$$* a x[n] + b y[n] \xleftrightarrow{\text{FT}} a X(e^{j\omega}) + b Y(e^{j\omega})$$

$$* x[n-n_0] \xleftrightarrow{\text{FT}} e^{-j\omega n_0} X(e^{j\omega})$$

$$* x^*[n] \xleftrightarrow{\text{FT}} X^*(e^{-j\omega})$$

$$* x[-n] \xleftrightarrow{\text{FT}} X(e^{-j\omega})$$

$$* x[n] y[n] \xleftrightarrow{\text{FT}} \frac{1}{2\pi} \int_{-\pi}^{\pi} X(e^{j\theta}) Y(e^{j(\omega-\theta)}) d\theta$$

$$* X(e^{j\omega}) \xleftrightarrow{\text{FT}} X(e^{j\omega})$$

$$* e^{j\omega_0 n} x[n] \xleftrightarrow{\text{FT}} X(e^{j(\omega-\omega_0)})$$

$$* y[n] = x[n] * h[n] \Rightarrow Y(e^{j\omega}) = X(e^{j\omega}) H(e^{j\omega})$$

$$* \sum_{n=-\infty}^{\infty} |x[n]|^2 = \frac{1}{2\pi} \int_{-\pi}^{\pi} |X(e^{j\omega})|^2 d\omega$$

$$* e^{j\omega n} = e^{j(\omega + k 2\pi)n}$$

$$* \text{sinc} \triangleq \frac{\sin \pi f}{\pi f}$$

$$* \text{rect} \triangleq \begin{cases} 1, & |t| < T/2 \\ 0, & \text{else} \end{cases}$$

$$* \text{rect}(\frac{t}{T}) \xleftrightarrow{\text{FT}} T \text{sinc}(\frac{\omega T}{2\pi})$$

$$* \frac{\omega}{2\pi} \text{sinc}(\frac{\omega T}{2\pi}) \xleftrightarrow{\text{FT}} \text{rect}(\frac{\omega}{2\pi})$$

$$* \text{rect} \xleftrightarrow{\text{FT}} \text{sinc}$$

$$* \text{sinc} \xleftrightarrow{\text{FT}} \text{rect}$$

$$* f(t) \xleftrightarrow{\text{FT}} g(\omega)$$

$$* g(t) \xleftrightarrow{\text{FT}} 2\pi f(\omega)$$

$$* X(j\omega) = \frac{1}{j\omega}$$

$$|X(j\omega)| = \frac{1}{\sqrt{\omega^2 + a^2}}$$

$$\angle X(j\omega) = -\tan^{-1}(\frac{\omega}{a})$$