$\frac{1}{T} = f \cdot 2000\pi t \rightarrow 2\pi m$

$t = 1$

$f = 1$

$\frac{m}{1000} = \frac{f}{} = \frac{1}{1000}$ $t = \boxed{1000}$

$t_s \geq 2000.$

$t_s \geq 2.$ $a_1 e^{-j\omega t} \; a_1 e^{-j\omega} \; a_1 e^{j\omega t} \; a_1 e^{-j\omega}$

$a_0 = -\frac{1}{2}$

Fourier Series

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

$$a_k = \frac{1}{T} \int_0^T x(t) e^{-jk\omega_0 t} dt$$

Linearity :- $Ax(t) + By(t) \xleftrightarrow{FS} Aa_k + Bb_k$

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

Time reversal :- $x(-t) \xleftrightarrow{FS} a_{-k}$

Time Scaling :- $\sum_{k=-\infty}^{\infty} a_k e^{jk(\alpha\omega_0)t} = x(\alpha t)$

Multiplication :- $x(t) \xleftrightarrow{FS} a_k$

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

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

Conjugation :- $x^*(t) \xleftrightarrow{FS} a_k$

$x^*(t) \xleftrightarrow{FS} a^*_{-k}$

Parseval's :- $\frac{1}{T} \int_T |a_k e^{jk\omega_0 t}|^2 dt = |a_k|^2$

differentiation :- $x(t) \xrightarrow{FS} a_k$

$$\frac{dx(t)}{dt} \xrightarrow{FS} jk\omega_0 a_k$$

Integration :- $\int_{-\infty}^{t} x(t)\,dt \longrightarrow \frac{1}{jk\omega_0} a_k$

Fourier Transform

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

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

Linearity :- $ax(t) + by(t) = aX(j\omega) + bY(j\omega)$

Time shifting :- $x(t-t_0) \longleftrightarrow e^{-j\omega t_0} X(j\omega)$

Conjugation :- $x(t) \xleftrightarrow{F} X(j\omega)$

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

Differentiation :- $\frac{dx(t)}{dt} \xleftrightarrow{F} j\omega X(j\omega)$

Integration :- $\int_{-\infty}^{t} x(\tau)\,d\tau \xleftrightarrow{F} \frac{1}{j\omega} X(j\omega) + \pi X(0)\delta(\omega)$

Time & Freqeuency Scaling :- $x(at) = \frac{1}{|a|} X\left(\frac{j\omega}{a}\right)$

Duality :- $x(t) \longrightarrow X(j\omega)$

$X(t) \longrightarrow 2\pi x(-\omega)$

$-jtx(t) \xleftrightarrow{F} \frac{dX(j\omega)}{d\omega}$

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

$\frac{-1}{jt}x(t) + \pi x(0)\delta(t) \xleftrightarrow{F} \int_{-\infty}^{\omega} x(\alpha)\,d\alpha$

Parseval's :- $\int_{-\infty}^{\infty} |x(t)|^2 dt = \frac{1}{2\pi}\int_{-\infty}^{\infty} |X(j\omega)|^2 d\omega$

Convolution :- $h(t) * x(t) \xleftrightarrow{F} H(j\omega)X(j\omega)$

Signal	FT	FS
$\sum_{K=-\infty}^{\infty} a_K e^{jK\omega_0 t}$	$2\pi\sum_{K=-\infty}^{\infty} a_K \delta(\omega-K\omega_0)$	a_K
$e^{j\omega_0 t}$	$2\pi\delta(\omega-\omega_0)$	$a_1=1 \quad a_K=0$
$\cos\omega_0 t$	$\pi[\delta(\omega-\omega_0)+\delta(\omega+\omega_0)]$	$a_1=a_{-1}=1/2 \quad a_K=0$
$x(t)=1$	$2\pi\delta(\omega)$	$a_0=1 \quad a_K=0$
$\sin\omega_0 t$	$\frac{\pi}{j}[\delta(\omega-\omega_0)-\delta(\omega+\omega_0)]$	$a_1=a_{-1}=1/2j \quad a_K=0$
$\begin{cases} 1 & \lvert t\rvert < T_1 \\ 0 & T_1 < \lvert t\rvert < T/2 \end{cases}$	$\sum_{K=-\infty}^{\infty} \frac{2\sin K\omega_0 T_1}{K}\delta(\omega-K\omega_0)$	$\frac{\sin K\omega_0 T_1}{K\pi}$

$\sum_{n=-\infty}^{\infty} \delta(t-nT)$	$\frac{2\pi}{T}\sum_{K=-\infty}^{\infty}\delta\left(\omega-\frac{2\pi K}{T}\right)$	$a_K = \frac{1}{T}$
$x(t) = \begin{cases} 1 & \lvert t\rvert < T_1 \\ 0 & \lvert t\rvert > T_1 \end{cases}$	$\frac{2\sin\omega T_1}{\omega}$	—
$\frac{\sin\omega t}{\pi t}$	$\begin{matrix} 1 & \lvert\omega\rvert < W \\ 0 & \lvert\omega\rvert > W \end{matrix}$	
$\delta(t)$	1	
$u(t)$	$\frac{1}{j\omega} + \pi\delta(\omega)$	
$\delta(t-t_0)$	$e^{-j\omega t_0}$	
$e^{-at}u(t)$	$\frac{1}{a+j\omega}$	
$te^{-at}u(t)$	$\frac{1}{(a+j\omega)^2}$	
$\frac{t^{n-1}}{(n-1)!}e^{-at}u(t)$	$\frac{1}{(a+j\omega)^n}$	

Laplace

$$X(s) = \int_{-\infty}^{\infty} x(t)\, e^{-st}\, dt$$

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

Linearity :- $a x_1(t) + b x_2(t) \longleftrightarrow a X_1(s) + b X_2(s)$

$R_1 \cap R_2$

Time Shifting :- $x(t - t_0) \longleftrightarrow e^{-st_0} X(s)$ R

Shift in S domain :- $e^{s_0 t} x(t) \longleftrightarrow X(s - s_0)$

$R + Re\{s_0\}$

$e^{j\omega_0 t} x(t) \longleftrightarrow X(s - j\omega_0)$

Time scaling :- $x(at) \longleftrightarrow \frac{1}{|a|} X\left(\frac{s}{a}\right)$

$R_1 = aR$

Conjugation :- $x^*(t) \longleftrightarrow X^*(s^*)$ R

Convolution :- $x_1(t) * x_2(t) \longleftrightarrow X_1(s)\, X_2(s)$

$R_1 \cap R_2$

Differentiation :- $\frac{dx(t)}{dt} \longleftrightarrow sX(s)$

$-tx(t) \longleftrightarrow \frac{dX(s)}{ds}$ R

Integration :- $\int_{-\infty}^{t} x(\tau)\, d\tau \longleftrightarrow \frac{1}{s} X(s)$

$R \cap \{Re\{s\} > 0\}$

Signal	LT	ROC
$\delta(t)$	1	All s
$u(t)$	$\frac{1}{s}$	$Re\{s\} > 0$
$-u(-t)$	$\frac{1}{s}$	$Re\{s\} < 0$
$\frac{t^{n-1}}{(n-1)!} u(t)$	$\frac{1}{s^n}$	$Re\{s\} > 0$
$-\frac{t^{n-1}}{(n-1)!} u(-t)$	$\frac{1}{s^n}$	$Re\{s\} < 0$
$e^{-\alpha t} u(t)$	$\frac{1}{s+\alpha}$	$Re\{s\} > -\alpha$
$-e^{-\alpha t} u(t)$	$\frac{1}{s+\alpha}$	$Re\{s\} < -\alpha$
$\frac{t^{n-1}}{(n-1)!} e^{-\alpha t} u(t)$	$\frac{1}{(s+\alpha)^n}$	$Re\{s\} > -\alpha$
$-\frac{t^{n-1}}{(n-1)!} e^{-\alpha t} u(t)$	$\frac{1}{(s+\alpha)^n}$	$Re\{s\} < -\alpha$
$\delta(t-T)$	e^{-sT}	All s
$(\cos \omega_0 t) u(t)$	$\frac{s}{s^2+\omega_0^2}$	$Re\{s\} > 0$
$(\sin \omega_0 t) u(t)$	$\frac{\omega_0}{s^2+\omega^2}$	$Re\{s\} > 0$

$(e^{-\alpha t}\cos\omega_0 t)\,u(t)$	$\frac{s+\alpha}{(s+\alpha)^2+\omega^2}$	$Re\{s\} > -a$
$(e^{-\alpha t}\sin\omega_0 t)\,u(t)$	$\frac{\omega_0}{(s+\alpha)^2+\omega^2}$	$Re\{s\} > -\alpha$
$u_n(t) = \frac{d^n \delta(t)}{dt^n}$	s^n	All s
$u_{-n}(t) = u(t) * \cdots * u(t)$	$\frac{1}{s^n}$	$Re\{s\} > 0$