$\arctan(\frac{1}{\sqrt{3}}) = \frac{\pi}{6}$, $\arctan(\sqrt{3}) = \frac{\pi}{3}$

$\sin n\pi = 0$
$1 - \cos n\pi = 2$ for odd n

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

$\sin x \sin y = {}^1\!/\!_2[\cos(x-y) - \cos(x+y)]$
$\cos x \cos y = {}^1\!/\!_2[\cos(x-y) + \cos(x+y)]$
$\sin x \cos y = {}^1\!/\!_2[\sin(x-y) + \sin(x+y)]$

$C\mathrm{c}\,(\omega_0 t + \theta) = C\,\mathrm{c}\,(\theta)\,\mathrm{c}\,(\omega_0 t) - C\mathrm{s}\,(\theta)\mathrm{s}\,(\omega_0 t)$

$\theta = \tan^{-1}(-b/a)$, $\pm\pi$ when $a < 0$
$\sin t = \cos(t - \pi/2)$

$\cos x = \frac{1}{2}\,[e^{jx} + e^{-jx}]$
$\sin x = \frac{1}{2j}\,[e^{jx} - e^{-jx}]$
$e^{j\omega t} = \cos(\omega t) + j\sin(\omega t)$

$z^* = a - jb = re^{-j\theta}$
$u^* v^* = (uv)^*$

$\angle z = \tan^{-1}(b/a)$, $\pm\pi$ in Q2 and Q3

$z^{\frac{1}{n}} = r^{\frac{1}{n}} e^{j\frac{\theta + 2\pi m}{n}}$

$\int \cos^2 at\, dt = \frac{t}{2} + \frac{\sin 2at}{4a}$

$\int t\cos at\, dt = \frac{1}{a^2}(\cos at + at\sin at)$
$\int t^2 \cos at\, dt = \frac{1}{a^3}(2at\mathrm{c}\,at - 2\mathrm{s}\,at + a^2t^2\mathrm{s}\,at)$

$\int te^{at}\, dt = \frac{1}{a^2}\, e^{at}(at - 1)$
$\int t^2 e^{at}\, dt = \frac{1}{a^3}\, e^{at}(a^2t^2 - 2at + 2)$

$\int e^{at}\, \cos bt\, dt = \frac{1}{a^2+b^2}\, e^{at}(a\cos bt + b\sin bt)$

$\int \frac{1}{x^2+a^2}\, dx = \frac{1}{a}\tan^{-1}\frac{x}{a}$

$\mathcal{E}_f = \int_{-\infty}^{\infty} |f(t)|^2 dt$ (complex);
$P_f = \lim_{T\to\infty} \frac{1}{T}\int_{-T/2}^{T/2} |f(t)|^2 dt$;
rms power $= \sqrt{P_f}$

Cont; analog; periodic (extension); (non/anti)causal; energy/power (both); deterministic/stochastic (carries info)

$\int f(t)\cdot\delta(t - t_0)dt = f(t_0)$ (f cont at t_0)

out–in $f(2x-6)$: shift by 6, scale by 2;
$f(2(x-6))$: scale by 2, shift by 6

$f_e(t) = {}^1\!/\!_2[f(t) + f(-t)]$;
$f_o(t) = {}^1\!/\!_2[f(t) - f(-t)]$

L: $\mathcal{T}[kf_1(t) + f_2(t)] = ky_1(t) + y_2(t)$.
$\mathcal{T}$: $\sum_{k=0} a_k D^k\, y(t) = \sum_{l=0} b_l D^l\, f(t)$,
L if a_k, b_l are not functions of $y(t)$, $f(t)$
E. $\sin\dot{y}(t) + t^2 y(t) = (t+3)f(t)$

TI: $\mathcal{T}[f(t-\tau)] = y(t-\tau)$.
a_k, b_l indep of t. (const coeff)
Let $g(t) \equiv f(t-\tau)$, find $z(t) = \mathcal{T}[g(t)]$

Causal: $y(t)$ dep only on $f(\tau)$, $\tau < t$. Just compare t and τ.

Ins/dyn: y only dep f at present (no $\int$)

Invertible: given $y(t)$, we can know $f(t)$

$c(t) \equiv \int_{-\infty}^{\infty} f(\tau)g(t-\tau)d\tau$

$f * g = g * f$

$f * (g + h) = f * h + g * h$

$f * (g * h) = (f * g) * h$

Pf: $f * (g * h) = f * (h * g) =$
$\int f(\tau_1) \int h(\tau_2)\, g(t - \tau_1 - \tau_2)\, d\tau_2\, d\tau_1$

$f(t - T_1) * g(t - T_2) = c(t - T_1 - T_2)$

$f(at) * g(at) = |{}^1\!/\!_a|\, c(at)$ (even/odd)

$f^{(m)}(t) * g^{(n)}(t) = c^{(m+n)}(t)$

Graph: shift LEFT by t, and reflect.
Every τ replaced by $t - \tau$, reverted

$f(t) * \delta(t - T) = f(t - T)$

$u(t) * u(t) = t\,u(t)$

$e^{at}\,u(t) *\, u(t) = \frac{1-e^{at}}{-a}\,u(t)$

$e^{at}\,u(t) * e^{bt}\,u(t) = \frac{e^{at}-e^{bt}}{a-b}\,u(t)$ $(te^{at}\,u(t))$

$e^{at}\,u(t) * e^{bt}\,u(-t) = \frac{e^{at}\,u(t) + e^{bt}\,u(-t)}{b-a}$

$te^{at}\,u(t) * e^{at}\,u(t) = {}^1\!/\!_2\, t^2 e^{at}\,u(t)$

$t^m\,u(t) * t^n\,u(t) = \frac{m!n!}{(m+n+1)!}\,t^{m+n+1}\,u(t)$

Don't forget $[u(t + T_1) - u(t - T_2)]$ term

$Q(D)y(t) = P(D)f(t)$, typically $\int f$
Assume causal input $f(t)u(t)$

$y_{zs}(t) = f(t) * h(t)$ from input
$y_{zs}(0^-) = 0$, $y_{zs}(0^+) \neq 0$

Let $h(t) = \mathcal{T}[\delta(t)]$ (impulse response)
$y_{zs}(t) = \mathcal{T}[f(t)] = \mathcal{T}[f(t) * \delta(t)]$
$= \mathcal{T}[\lim \sum f(n\Delta\tau)\delta(t - n\Delta\tau)\Delta\tau]$
$= \lim \sum f(n\Delta\tau)h(t - n\Delta\tau)\Delta\tau = f * h$

$y_{zi}(t)$ from ini, $f(t) = 0$, $Qy_{zi}(t) = 0$;
$y_{zi}(0^-) = y_{zi}(0^+)$, $\dot{y_{zi}}(0^-) = \dot{y_{zi}}(0^+)$

$\mathcal{E}_e = \int_{t_1}^{t_2} [e(t)]^2 dt = \int_{t_1}^{t_2} f^2(t)dt$
$-2\sum c_i \int_{t_1}^{t_2} f(t)x_i(t)dt + \int_{t_1}^{t_2} (\sum c_i x_i(t))^2 dt$
$= \mathcal{E}_f - 2\sum\langle f, x_i\rangle + (\sum c_i^2 \int_{t_1}^{t_2} x_i(t)^2 dt +$
$\sum_{i\neq j} c_i c_j \int_{t_1}^{t_2} x_i(t)x_j(t)dt)$

$\frac{\partial\mathcal{E}_e}{\partial c_i} = 0 = -2\langle f(t), x_i(t)\rangle + 2\mathcal{E}_i c_i$
$\mathcal{E}_e^{\min} = \mathcal{E}_f - \sum_{i=1}^{N} c_i^2 \mathcal{E}_i$

$c_i = \frac{1}{\mathcal{E}_i}\langle f, x_i\rangle = \frac{\int f(t)x(t)dt}{\int f^2(t)dt}$

For ortho, $E_z = E_x + E_y$

$|u + v|^2 = |u|^2 + |v|^2 + u^*v + v^*u$

$\langle x(t), y(t)\rangle = \int_{t_1}^{t_2} x(t)y(t)^*\, dt$
$= \int_{t_1}^{t_2} x(t)y(t)dt$ if real
Use prod $\to$ sum identities

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

$b_n = \frac{2}{T_0}\int_{T_0} f(t)\sin(n\omega_0 t)\, dt$
Energy: T_0 for $n = 0$; $T_0/2$ else

Half-w sym: $f(t - {}^{T_0}\!/\!_2) = -f(t)$
$a_{n_{\text{odd}}} = \frac{4}{T_0}\int_0^{T_0/2} f(t)\cos(n\omega_0 t)\, dt$

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

$C_n\cos(n\omega_0 t + \theta_n) =$
${}^{C_n}\!/\!_2\,(e^{j(n\omega_0 t + \theta_n)} + e^{-j(n\omega_0 t + \theta_n)}) =$
$(\frac{C_n}{2}e^{j\theta_n})e^{jn\omega_0 t} + (\frac{C_n}{2}e^{-j\theta_n})e^{-jn\omega_0 t}$

$F_n = \frac{C_n}{2}\, e^{j\theta_n} = \frac{1}{2}(a_n - jb_n) = |F_n|e^{j\angle F_n}$
$F_{-n} = \frac{C_n}{2}\, e^{-j\theta_n}$

W: finite $\int$, fin a, b, fin power

S: fin m/m/dcont over T_0, $\to \frac{f(t_0^+) + f(t_0^-)}{2}$

Time shift: $f(t - t_0) \leftrightarrow F_n e^{-jn(\omega_0 t_0)}$, $|F_n|$ same, $\angle F_n$ shifted by $-(\omega_0 t_0)n$

Reversal: $f(-t) \leftrightarrow F_{-n}$

Scal: $T = {}^{T_0}\!/\!_a$, $\omega = a\omega_0$

Multip (same T_0): $f(t)g(t) \leftrightarrow F_n * G_n$
$\frac{1}{T_0}\int_{T_0} f(t)g(t)e^{jn\omega_0 t}\, dt =$
$\frac{1}{T_0}\int(\sum F_m e^{jm\omega_0 t})(\sum G_k e^{jk\omega_0 t})e^{-jn\omega_0 t}\, dt$
$= \sum_m \sum_k F_m G_k \frac{1}{T_0}\int_{T_0} e^{j(m+k-n)\omega_0 t}\, dt$
$= \sum_m \sum_k F_m G_k \langle e^{j(m+k)\omega_0 t}, e^{jn\omega_0 t}\rangle$
$= \sum_{k=-\infty}^{\infty} G_k F_{n-k}$

Conjugation: $f(t)^* = F_{-n}^*$

Parseval (power): $P_f = \frac{1}{T_0}\int_{T_0} f(t)f(t)^* dt$
$= \frac{1}{T_0}\int_{T_0}(\sum_n F_n e^{jn\omega_0 t})(\sum_m F_m e^{jm\omega_0 t})^* dt$
$= \sum_n \sum_m F_n F_m^* \frac{1}{T_0}\int_{T_0} e^{j(n-m)\omega_0 t} dt$
$= \sum_n |F_n|^2 \cdot 1$

f real $\to |F|$ even, $\angle F$ odd
f real, even $\to F$ re, e; $F_{-n} = F_n = F_n^*$
f re, od $\to F$ im, o; $-F_{-n} = F_n = -F_n^*$

$f_e(t) \leftrightarrow \mathrm{Re}\{F_n\}$
$f_o(t) \leftrightarrow j\,\mathrm{Im}\{F_n\}$

Square ($A = 1$, $T = 2\pi$, $\omega = 1$)
$\frac{4}{\pi}(\cos t - \frac{1}{3}\cos 3t + \frac{1}{5}\cos 5t - ...)$
$\frac{4}{\pi}(\sin t + \frac{1}{3}\sin 3t + \frac{1}{5}\sin 5t + ...)$

Triangle: $\frac{8}{\pi^2}(\sin t - \frac{1}{9}\sin 3t + \frac{1}{25}\sin 5t - ...)$
$\frac{8}{\pi^2}(\cos t + \frac{1}{9}\cos 3t + \frac{1}{25}\cos 5t + ...)$

Sawtooth: $\frac{2}{\pi}(\sin t - \frac{1}{2}\sin 2t + \frac{1}{3}\sin 3t - ...)$
$\frac{2}{\pi}(-\sin t - \frac{1}{2}\sin 2t - \frac{1}{3}\sin 3t - ...)$

δ train: $\delta_{T_0}(t) = \sum_{n=-\infty}^{\infty}\delta(t - nT_0)$
$\frac{1}{T_0}\sum_{n=-\infty}^{\infty} e^{jn\omega_0 t}$

0.0.1 Fourier transform

Let $F(\omega) \equiv \int f(t)e^{-j\omega t}\,dt$

$F_n = \frac{1}{T_0}\int_{T_0} f(t)e^{-jn\omega_0 t}\,dt$

Limit as $\omega_0 = \Delta\omega \to 0$,
$F_n = \frac{\Delta\omega}{2\pi}\int f(t)e^{-jn\Delta\omega t}\,dt \equiv \frac{\Delta\omega}{2\pi}F(n\Delta\omega)$

$f_{T_0}(t) = \sum F_n\, e^{jn\omega_0 t} =$
$\sum \frac{\Delta\omega}{2\pi}F(n\Delta\omega)\, e^{jn\Delta\omega t}$

$f(t) = \lim f_{T_0}(t) = \frac{1}{2\pi}\int F(\omega)e^{jt\omega}d\omega$

$F(\omega) = |F(\omega)|\, e^{j\angle F(\omega)}$

Re signals: sym of $||$ and $\angle$

Existence: energy signal ($|e^{-j\omega t}| = 1$)
Strong: fin num max/min/discont

0.0.2 FT Table

$\delta(t) \leftrightarrow 1$
$1 \leftrightarrow 2\pi\delta(\omega)$

$e^{j\omega_0 t} \leftrightarrow 2\pi\delta(\omega - \omega_0)$
$\cos\omega_0 t \leftrightarrow \pi[\delta(\omega+\omega_0) + \delta(\omega-\omega_0)]$
$\sin\omega_0 t \leftrightarrow j\pi[\delta(\omega+\omega_0) - \delta(\omega-\omega_0)]$

$\sum \delta(t - nT_0) \leftrightarrow \omega_0 \sum \delta(\omega - n\omega_0)$

$e^{-at}\,u(t) \leftrightarrow \frac{1}{a+j\omega}$
$e^{-a|t|} \leftrightarrow \frac{2a}{a^2+\omega^2}$
$u(t) = \lim_{a\to 0} e^{-at}u(t) \leftrightarrow \lim \frac{1}{a+j\omega}$
$= \lim(\frac{a}{a^2+\omega^2} - j\frac{\omega}{a^2+\omega^2}) = \pi\delta(\omega) + \frac{1}{j\omega}$
$\mathrm{sgn}(t) \leftrightarrow \frac{2}{j\omega}$

$t^n e^{-at}u(t) \leftrightarrow \frac{n!}{(a+j\omega)^{n+1}}$

$\mathrm{c}\,\omega_0 t\, u(t) \leftrightarrow \frac{\pi}{2}(\delta(-) + \delta(+)) + \frac{j\omega}{\omega_0^2 - \omega^2}$
$\sin\omega_0 t\, u(t) \leftrightarrow \frac{\pi}{2j}(\delta(-) - \delta(+)) + \frac{\omega_0}{\omega_0^2-\omega^2}$
$e^{-at}\cos\omega_0 t\, u(t) \leftrightarrow \frac{a+j\omega}{(a+j\omega)^2+\omega_0^2}$
$e^{-at}\sin\omega_0 t\, u(t) \leftrightarrow \frac{\omega_0}{(a+j\omega)^2+\omega_0^2}$

$\mathrm{rect}(\frac{t}{\tau}) \leftrightarrow \tau\,\mathrm{sinc}(\frac{\tau}{2}\omega)$
$\frac{W}{\pi}\,\mathrm{sinc}(Wt) \leftrightarrow \mathrm{rect}(\frac{\omega}{2W})$

$\triangle(\frac{t}{\tau}) \leftrightarrow \frac{\tau}{2}\,\mathrm{sinc}^2(\frac{\tau}{4}\omega)$
$\frac{W}{2\pi}\,\mathrm{sinc}^2(\frac{W}{2}t) \leftrightarrow \triangle(\frac{\omega}{2W})$

$[\omega^2 \mathrm{r}\,(\frac{\omega}{2\omega_0})] \leftarrow \frac{1}{2\pi}\frac{e^{j\omega t}}{(jt)^3}(-\omega^2t^2 - 2j\omega t + 2)_{-\omega_0}^{\omega_0}$
$= \frac{(\omega_0^2t^2-2)\sin\omega_0 t + 2\omega_0 t\cos\omega_0 t}{\pi t^3}$

$[\frac{|\omega|}{\omega_0}\,\mathrm{rect}(\frac{\omega}{2\omega_0})] \leftarrow \frac{\cos\omega_0 t + \omega_0 t\sin\omega_0 t - 1}{\omega_0\pi t^2}$

0.0.3 Frequency domain properties

Linearity

Time shift: $f(t-t_0) \leftrightarrow F(\omega)e^{-jt_0\omega}$
$|F|$ unchanged; $\angle F = -t_0\omega$, lin shift

Freq shift: $f(t)e^{j\omega_0 t} \leftrightarrow F(\omega - \omega_0)$

t-f dual $f(t) \leftrightarrow F(\omega)$, $F(t) \leftrightarrow 2\pi f(-\omega)$
Pf. $f(t) = \frac{1}{2\pi}\int F(\lambda)e^{jt\lambda}\,d\lambda$
$2\pi f(-t) = \int F(\lambda)e^{-tj\lambda}\,d\lambda = \mathcal{F}[F(\lambda)]$

Reversal: $f(-t) \leftrightarrow F(-\omega)$

Scaling: $f(at) \leftrightarrow \frac{1}{|a|}F(\frac{\omega}{a})$

Convolution: $f * g \leftrightarrow FG$, $fg \leftrightarrow \frac{1}{2\pi}F * G$
$\mathcal{F}[f*g] = \int e^{-j\omega t}\int f(\tau)g(t-\tau)d\tau dt =$
$\int f(\tau)\mathcal{F}[g(t-\tau)]d\tau = \int f(\tau)G(\omega)e^{-j\omega\tau}d\tau$
$\frac{1}{2\pi}\mathcal{F}^{-1}[F*G] =$
$(\frac{1}{2\pi})^2\int e^{j\omega t}\int F(\lambda)G(\omega-\lambda)d\lambda d\omega$

Diff: $f^{(n)}(t) \leftrightarrow (j\omega)^n F(\omega)$ (diff $e^{j\omega t}$)

Int: $\int_{-\infty}^t f(\tau)d\tau \leftrightarrow \frac{1}{j\omega}F(\omega) + \pi F(0)\delta(\omega)$
$U(\omega) = \lim\frac{1}{a+j\omega} = \lim(\frac{a}{a^2+\omega^2} - j\frac{\omega}{a^2+\omega^2})$
$= \pi\delta(\omega) + \frac{1}{j\omega}$ ($\int \frac{a}{\omega^2+a^2}d\omega = \tan^{-1} = \pi$)
$\int = f(t) * u(t) \leftrightarrow F(\omega)U(\omega)$

Conjugation: $f(t)^* \leftrightarrow F(-\omega)^*$

Sym: Re $\leftrightarrow$ $||$ e, $\angle$ o ($F(-\omega) = F(\omega)^*$);
re, e $\leftrightarrow$ re, e; re, o $\leftrightarrow$ im, o

f even: $F(\omega) = 2\int_0^\infty f(t)\cos(\omega t)dt$
f odd: $F(\omega) = -2j\int_0^\infty f(t)\sin(\omega t)dt$

0.0.4 Parseval

Psval: $E_f = \int|f(t)|^2dt = \frac{1}{2\pi}\int|F(\omega)|^2d\omega$
for energy signal
Pf: $= \int ff^*dt = \int f(t)\mathcal{F}^{-1}[F(-\omega)^*]dt$
$= \int f(t)\frac{1}{2\pi}\int F(-\omega)^*e^{j\omega t}d\omega dt$
$= \frac{1}{2\pi}\int f(t)\int F(\lambda)^*e^{-jt\lambda}d\lambda dt = \int dtd\lambda$
$\Delta E_f = \frac{2}{2\pi}\int_{\omega_1}^{\omega_2}|F(\omega)|^2d\omega$

Autocorrelation
$\psi_f(t) \equiv \int f(\tau)f(\tau - t)d\tau \leftrightarrow |F(\omega)|^2$

0.0.5 AM

$m(t)\cos(\omega_c t) \leftrightarrow \frac{1}{2}[M(\omega+\omega_c) + M(\omega-\omega_c)]$
$e(t) = m(t)\cos^2\omega_c t$
$E(\omega) = \frac{1}{2}M + \frac{1}{4}[M(\omega+2\omega_c) + M(\omega-2\omega_c)]$

SSB: 1/4 gain

$\phi_{\mathrm{AM}}(t) = [A + f(t)]\cos(\omega_0 t)$
$A \ge f(t)$ for all t

modulation index $\mu \equiv f_{\max}/A$

$\mu = \infty$, SC, $\mu = 1$, marginal

0.0.6 LTIC system transmission

Let $e^{j\omega t} \to H(\omega)e^{j\omega t}$

$\lim\sum\frac{F(n\Delta\omega)\Delta\omega}{2\pi}e^{jn\Delta\omega t}$
$\to \lim\sum\frac{F(n\Delta\omega)H(n\Delta\omega)\Delta\omega}{2\pi}e^{jn\Delta\omega t}$
$= \frac{1}{2\pi}\int F(\omega)H(\omega)e^{j\omega t}d\omega$

$Y(\omega) = F(\omega)H(\omega)$

Distortionless: $y(t) = kf(t - t_d)$,
so $H(\omega) = ke^{-j\omega t_d}$

Payley-Wiener: H realizable, h causal iff
$\int\frac{|\ln|H(\omega)||}{1+\omega^2}d\omega < \infty$ (consecutive 0s)
$\hat{h}(t) = h(t)u(t)$

0.0.7 Periodic FT

$f(t) = \sum F_n e^{jn\omega_0 t}$,
$\mathcal{F}[f(t)] = 2\pi\sum F_n\delta(\omega - n\omega_0)$

$Y = F(\omega)H(\omega) =$
$2\pi\sum F_n H(n\omega_0)\delta(\omega - n\omega_0)$
$Y_n \equiv F_n H(n\omega_0)$. Periodic with same ω_0

Eigen: $f(t) = e^{j\omega_0 t}$, $Y_1 = H(1\omega_0)$,
$y(t) = H(1\omega_0)e^{j\omega_0 t}$

$f(t) = \cos(\omega_0 t + \theta)$, assume $h(t)$ real
$y = \frac{1}{2}(e^{j(\theta+\omega_0 t)}H(\omega_0) + e^{-j(\theta+\omega_0 t)}H(-\omega_0))$
$= |H(\omega_0)|\cos(\omega_0 t + \theta + \angle H(\omega_0))$

$\cos 2t * e^{-3t}u(t) \equiv f * h$
$= |H(2)|\cos(2t + \angle H(2))$

0.0.8 Sampling

$\overline{f}(t) \equiv f(t)\delta_{T_s}(t) = \sum f(nT_s)\delta(t - nT_s)$
$\overline{F}(\omega) = \frac{1}{2\pi}F(\omega) * [\frac{2\pi}{T_s}\sum\delta(\omega - n\omega_s)]$
$= \frac{1}{T_s}\sum F(\omega - n\omega_s)$

$\omega_s \ge 4\pi B$, $F_s \ge 2B$

$F(\omega) = \overline{F}(\omega)T_s\,\mathrm{rect}(\frac{\omega}{4\pi B})$
If $F_s = 2B$, $f(t) = \overline{f}(t) * \frac{2B}{F_s}\,\mathrm{sinc}(2\pi Bt)$
$= \sum f(nT_s)\delta(t - nT_s) * \mathrm{sinc}(2\pi Bt)$
$= \sum f(nT_s)\,\mathrm{sinc}(2\pi Bt - n\pi)$
ana FS, basis: sinc, interpolation formula

If $F_s > 2B$, $f(t) = \sum f(nT_s)w(t - nT_s)$
for some relaxed filter $w(t)$

Anti-alias before sampling: LPF of $F_s/2$

Practical sampling:
$p_T(t) = \frac{\tau}{T_s} + \sum(\frac{2}{\pi n}\sin(n\pi\frac{\tau}{T_s}))\cos(n\omega_s t)$
$P_T(\omega) = 2\pi\frac{\tau}{T_s}\delta(\omega)$
$+ \sum\frac{2\sin(\dots)}{n}[\delta(\omega+n\omega_s) + \delta(\omega-n\omega_s)]$