1.

a) power signal (periodic) $P_x = \frac{A^2}{2}$ (avg. power over period)

b) energy signal (finite in time) $E_x = \frac{A^2 T_0}{2}$

c) energy " (finite in time)

$$E_x = \int_0^\infty A^2 e^{-2at}\, dt = \frac{A^2}{2a}$$

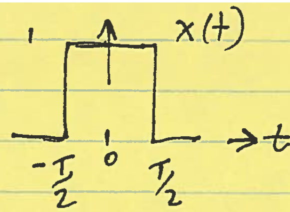
d) power signal (periodic)

fundamental freq $f_0 = \frac{1}{2\pi}$ $T_0 = 2\pi$

$P_x = 13$

2.

$\mathrm{rect}\left(\frac{t}{T}\right)$



$E_x = \int_{-\infty}^{\infty} x^2(t) = T$ ← normalized energy

3.

we stated in class (from Parseval's thm. for F.S.)

$$G_x(f) = \sum_{n=-\infty}^{\infty} |c_n|^2 \delta(f - nf_0) \qquad P_x = \int_{-\infty}^{\infty} G_x(f)\,df = \sum_{n=-\infty}^{\infty} |c_n|^2$$

(from sampling property of Dirac δ fn.)

4.

for periodic fn.

$$R_x(\tau) = \frac{1}{T_0}\int_{-\frac{T_0}{2}}^{T_0/2} [A\cos(2\pi f_0 t + \phi)\, A\cos(2\pi f_0 t + 2\pi f_0 \tau + \phi)]\,dt$$

$$\downarrow$$

$K = 2\pi f_0 t + \phi$

$L = 2\pi f_0 \tau$

$$\cos(K)\cos(K+L)$$

$$\cos(K)[\cos(K)\cos(L) - \sin(K)\sin(L)]$$

$$\cos^2(K)\cos(L) - \sin(K)\sin(L)\cos(K)$$

$$\Big(\frac{1}{2} + \underbrace{\cos 2K}_{\text{integrates to zero over } T_0}\Big)\cos(L) - \underbrace{\sin(K)\sin(L)\cos(K)}_{\text{integrates to } \phi \text{ over } T_0}$$

$$R_x(\tau) = \frac{A^2}{2}\cos(2\pi f_0 \tau)$$

$$P_x = R_x(0) = \frac{A^2}{2}$$

5.

a) avg. val of $x(t) = 1 + \cos 2\pi f_0 t$

$$\langle x(t) \rangle = \frac{1}{T_0}\int_{-\frac{T_0}{2}}^{\frac{T_0}{2}} (1+\cos 2\pi f_0 t)\,dt = 1 = \mu$$

b) ac power

$$\sigma^2(t) = \langle (x-\mu)^2 \rangle = \frac{1}{T_0}\int_{-\frac{T_0}{2}}^{\frac{T_0}{2}} \cos^2 2\pi f_0 t\,dt = \frac{1}{2}$$

c) rms val of $x(t)$

$$\left[\langle x^2(t) \rangle\right]^{\frac{1}{2}} = \left[\frac{1}{T_0}\int_{-T_0/2}^{T_0/2} (1+\cos 2\pi f_0 t)^2\,dt\right]^{\frac{1}{2}} = \sqrt{\frac{3}{2}}$$

6.

$$X(f) = \text{sinc}\, f = \frac{\sin \pi f}{\pi f}$$

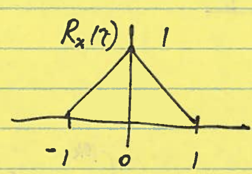
$$\psi_x(f) = |X(f)|^2 = \text{sinc}^2(f)$$

$$|X(f)|^2 = F.T.\{R_x(\tau)\}$$

$\Rightarrow$ looking up Table A.1 of Sklar...

$$F.T.\left\{1 - \frac{|\tau|}{T}\right\} = T\,\text{sinc}^2(fT)$$

$\therefore$ in our case $R_x(\tau) = \begin{cases} 1 - |\tau| & |\tau| < 1 \\ 0 & \text{otherwise} \end{cases}$



7.

$$\int_{-\infty}^{\infty} e^{-t^2}\,\delta(t-2)\,dt = e^{-2^2} = 0.0183$$

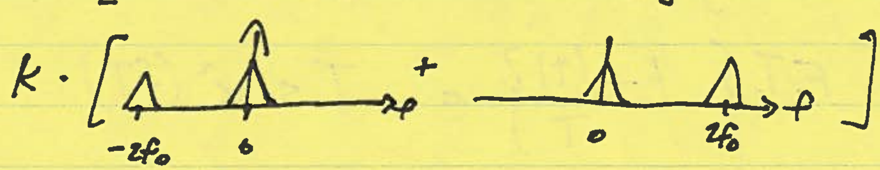
8.

$$X_2(f) = k\left[\delta(f-f_0) + \delta(f+f_0)\right]$$

$$X_1 * X_2 = X_1 * k\left[\delta(f-f_0) + \delta(f+f_0)\right]$$

$$C(f) = \int_{-\infty}^{\infty} X_1(f-s)\,k\left[\delta(s-f_0) + \delta(s+f_0)\right]ds$$

$$= k\cdot\left[X_1(f-f_0) + X(f+f_0)\right]$$



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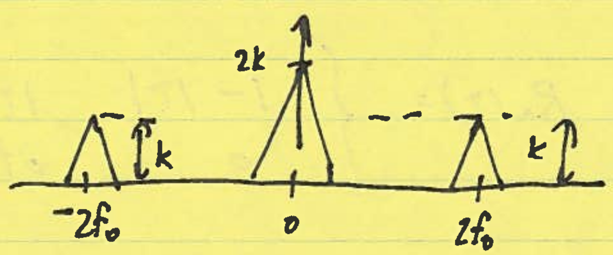


9.

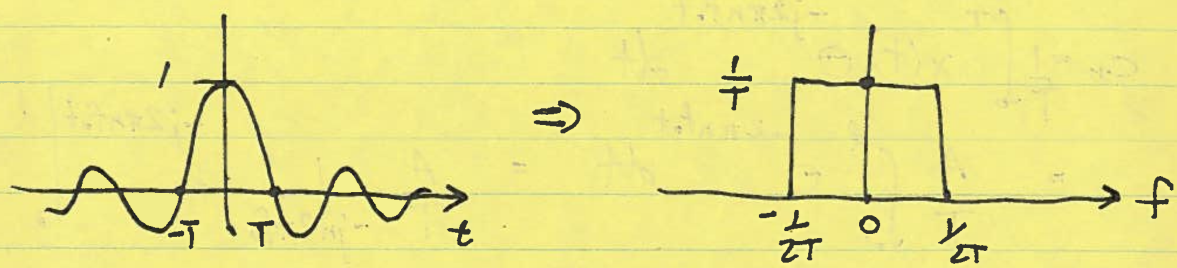
a) $P_x = \int_{-10k}^{10k} G_x \, df = 2\int_{0}^{10k} G_x \, df = 2\int_{0}^{10k} 10^{-6} f^2 df$

$= 2\left[\frac{10^{-6} f^3}{3}\right]\Big|_{0}^{10k} = 667\ kW$

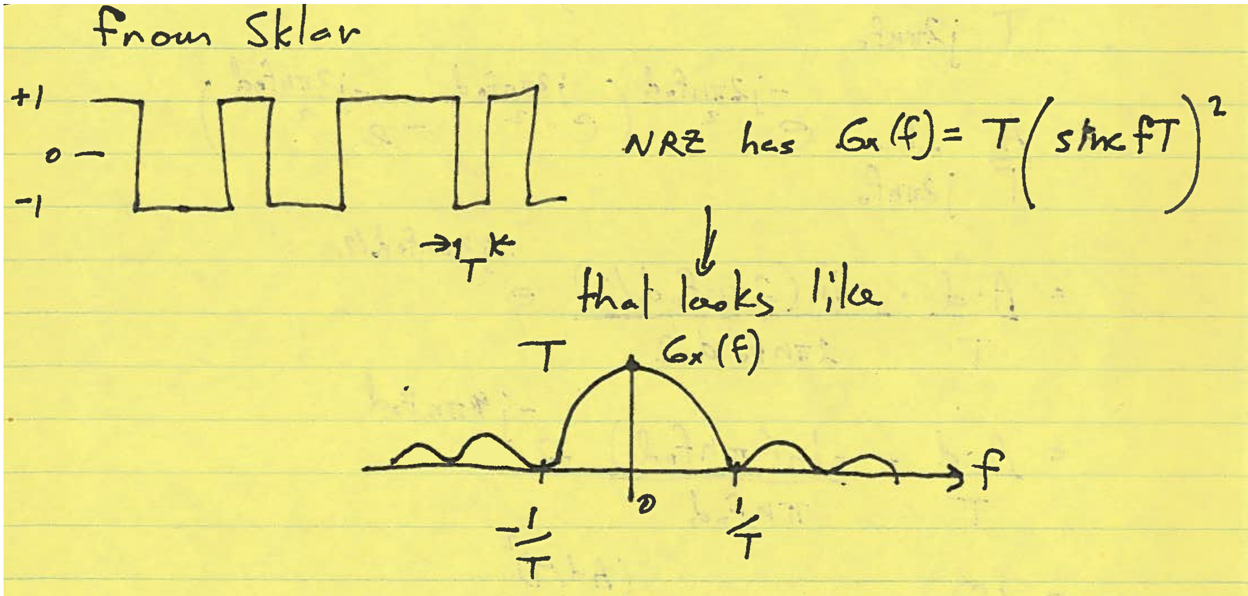
b) $2\int_{5k}^{6k} 10^{-6} f^2 = 2\left[\frac{10^{-6} f^3}{3}\right]\Big|_{5k}^{\cancel{10}6k} = 60.7\ kW$

10.

- channel coder
- sampler / quantizer
- equalizer
-)

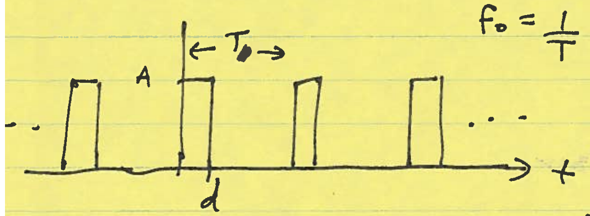


11.


from Sklar
+1
0
-1
T
NRZ has Gx(f) = T(sinc fT)^2
that looks like
T
Gx(f)
f
0
-1/T
1/T

12.

$f_0 = \frac{1}{T}$



~~be~~ periodic signal $\quad G_x(f) = \sum_{n=-\infty}^{\infty} |c_n|^2 \delta(f - nf_0)$

$$c_n = \frac{1}{T}\int_0^T x(t)\, e^{-j2\pi n f_0 t}\, dt$$

$$= \frac{A}{T}\int_0^d e^{-2\pi n f_0 t}\, dt = \frac{A}{T}\,\frac{1}{-jn2\pi f_0}\cdot e^{-j2\pi n f_0 t}\Big|_0^d$$

$$= \frac{A}{T}\,\frac{1}{j2\pi n f_0}\left(1 - e^{-j2\pi n f_0 d}\right)$$

$$= \frac{A}{T}\,\frac{1}{j2\pi n f_0}\cdot e^{-j\frac{2\pi n f_0 d}{2}}\left(e^{j\frac{2\pi n f_0 d}{2}} - e^{-j\frac{2\pi n f_0 d}{2}}\right)$$

$$= \frac{A\cdot d}{T}\cdot\frac{\sin(2\pi n f_0 d/2)}{2\pi n f_0\, d/2}\, e^{-j2\pi n f_0 d/2}$$

$$= \frac{A\cdot d}{T}\cdot\frac{\sin(\pi n f_0 d)}{\pi n f_0 d}\, e^{-j\pi n f_0 d}$$

$\therefore\ G_x(f) =$