Solution HW5_Ch5

Q1)

a) BW = 210 Hz $f_s = 420$ samples/sec

b) BW = 6500 Hz $f_s = 13,000$ samp/sec

c) BW = 2000 Hz $f_s = 400$ sample/sec

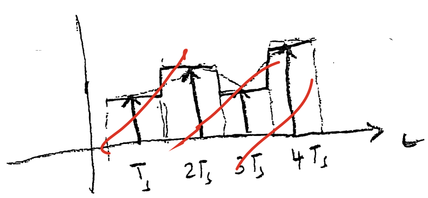
d) BW = 400 Hz $f_s = 800$

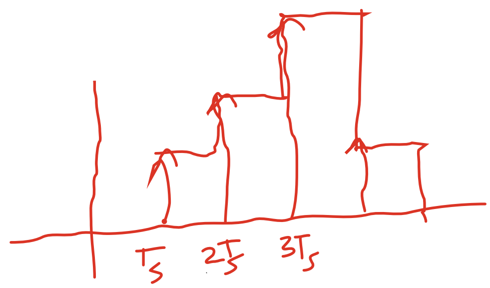
Q2)

a) $h(t) = u(t) - u(t - T_s) = \Pi\left(\frac{t - T_s/2}{T_s}\right)$

b) $H(f) = T_s \operatorname{Sinc}(\pi f T_s)\, e^{-j\pi f T_s}$

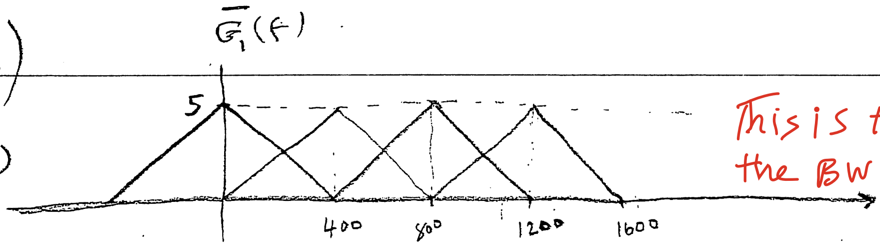
c)





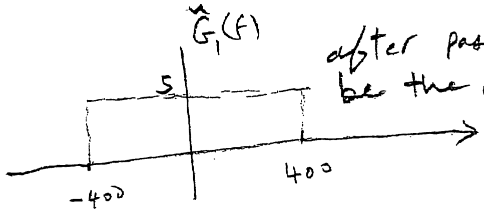
Q3)

a)

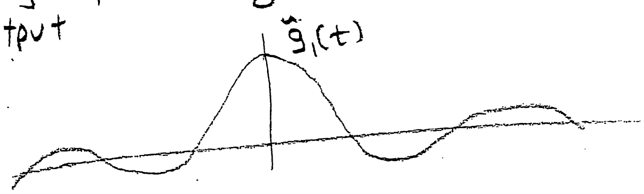


This is the answer if you choose the BW of the Filter 400 instead of $\frac{f_s}{2} = 200$

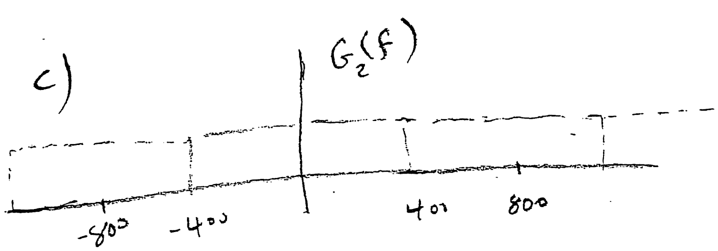
b)

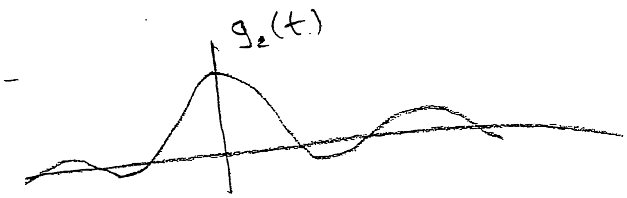


after passing $\bar{G}_1(f)$ through a LPF with $F_c = 400$, $\hat{G}_1(f)$ will be the output



c)

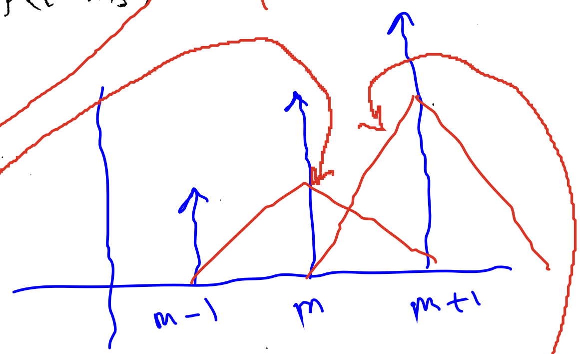




Q4) $h(t) = \Delta\left(\frac{t - T_s}{2T_s}\right)$

ideal sampling

$\sum_n g(nT_s)\,\delta(t - nT_s)$ → non-ideal Filtering Reconstruction Interpolation $p(t)$, $h(t) = p(t)$ → $\tilde{g}(t) = \sum_n g(nT_s)\,p(t - nT_s)$



$$\tilde{g}(t) = \sum_k g(kT_s)\,\Delta\left(\frac{t-(k+1)T_s}{2T_s}\right)$$

For $mT_s \le t \le (m+1)T_s$

$$\tilde{g}(t) = g((m-1)T_s)\left(1 - 2\,\frac{t - mT_s}{2T_s}\right) + g(mT_s)\left(1 + 2\,\frac{t-(m+1)T_s}{2T_s}\right)$$

$$= g((m-1)T_s) + \frac{g(mT_s) - g((m-1)T_s)}{T_s}\,(t - mT_s)$$

b) $H(f) = T_s\,\mathrm{sinc}^2(\pi f T_s)\,e^{-j2\pi f T_s}$

Q5) a) $f_s = 1.22(2B) = 1.22(2 \times 4.5\times10^6) = 10.98\times10^6$ samples/sec

b) 10 bits/sample

c) total bits per second $= 1.02(10.98\times10^6)(10) = 111.996\times10^6$ bits/sec

Channel BW $= (\#$ of pulse per seconds$)\cancel{\times}\,2 = \cancel{223.992}$ 56 MHz MHz

$= \cancel{0.224 \text{ GHz}}$

Q6) $\frac{S_o}{N_o} = 3L^2\,\frac{\overline{m^2(t)}}{m_p^2}$ $\xrightarrow{n_1=10}$ $\cancel{30}$ 1000 $= 3(2^{10})^2\,\frac{\overline{m^2(t)}}{m_p^2} \Rightarrow \frac{\overline{m^2(t)}}{m_p^2} = 10/(2^{20})$

$\cancel{42}$ 15,849 $= 3L^2\left(\frac{\overline{m_2(t)}}{m_p^2}\right) \Rightarrow \cancel{L^2 = \frac{42 \times 2^{20}}{3\times10}} \Rightarrow L = \cancel{1211.61}$ 4076.6 $\cancel{\Rightarrow L = 1212}$

$n_2 = \cancel{11}$ 12 $\quad BW_1 = \frac{n_1 f_s}{2} \quad BW_2 = \frac{n_2 f_s}{2} \quad$ Fraction $= \frac{BW_2}{BW_1} \times 10 = \frac{\cancel{11}\ 12}{10} = 1.\cancel{1}\,2$

% increase $= \cancel{1}\,20\%$

Q7) $V_p = 1$ $\quad \overline{m^2(t)} = 120\text{ mW}$ $\quad SNR = 36\text{ dB}$ $\quad n = ?$

$$3L^2 \frac{\overline{m^2(t)}}{m_p^2} \geq 10^{3.6} \Longrightarrow 3L^2 \frac{120\times10^{-3}}{1} \geq 10^{3.6} \Longrightarrow L \doteq 105.16$$

So $n = 7$ $\quad$ with $n=7$, the actual $SNR = 3(2^7)^2 \frac{120\times10^{-3}}{1} = 5898.24$

$$= 37.71\text{ dB}$$

Q8) $$\frac{\overline{m^2(t)}}{m_p^2} = \frac{120\times10^{-3}}{1} = 0.12$$

$$\frac{3L^2}{[\ln(1+\mu)]^2} \geq 10^{3.6} \Longrightarrow 0.1408\,L^2 \geq 10^{3.6} \Longrightarrow L = 168.12$$

$n = 8$ bits

The actual SNR for $n=8$ is 39.65

Q9)
a) $n = 7$

b) rate 4.2×10^6 bit/s $\quad$ Channel Bandwidth $= 2.1$ MHz

c) rate 4.8×10^6 bits/s $\quad$ Ch BW $= 2.4$ MHz

d) DS1 Carrier 1.544×10^6 bits/s $\Longrightarrow$ DS1 $= 4$ Carriers

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Q10)
a) $d[k]_{Peak} = 2A_m \sin(\theta_m)$

b) SNR Improvement $= G_p = (m_p/d_p)^2 = \dfrac{1}{4\sin^2\theta_m}$

Q11)
a) $|\dot{m}(t)|_{max} < E f_s \Longrightarrow E = \dfrac{\cancel{1.75}\ 10 \times 10^{\cancel{4}\,3}}{f_s}$

b) $N_o = \dfrac{E^2 B}{3 f_s} = 1.02\times10^8\ B/f_s^3$