Solution HW5_Ch5

Q1)

a) $BW = 210\ Hz$ $\quad F_s = 420$ samples/sec

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

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

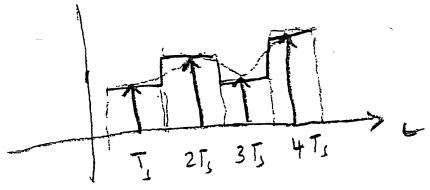
d) $BW = 400\ Hz$ $\quad f_s = 800$

Q2)

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

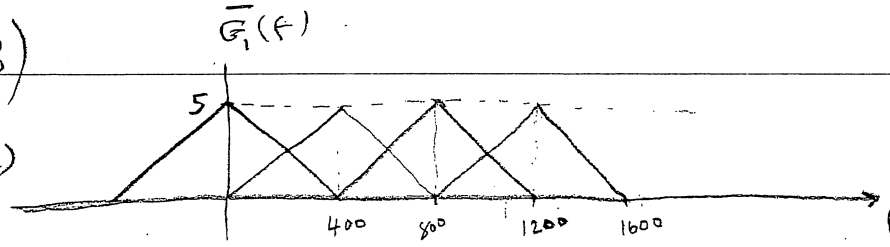
b) $H(f) = T_s\, Sinc(\pi f T_s)\, e^{-j\pi f T_s}$

c)

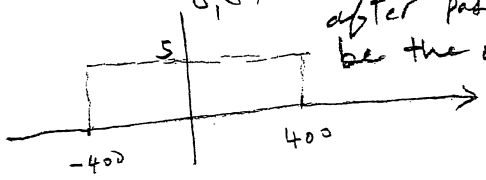


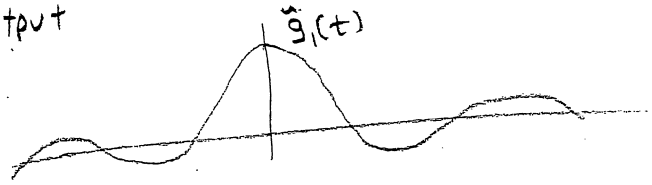
Q3)

a)

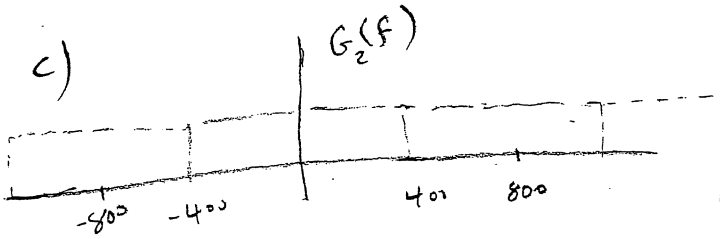


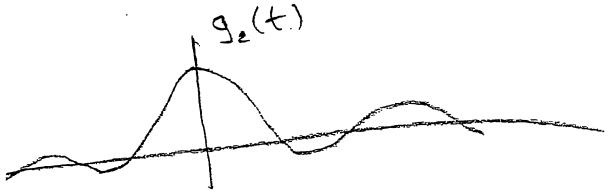
b) $\hat{G}_1(f)$ after passing $\bar{G}_1(f)$ through a LPF with $F_c = 400$, $\hat{G}_1(f)$ will be the output



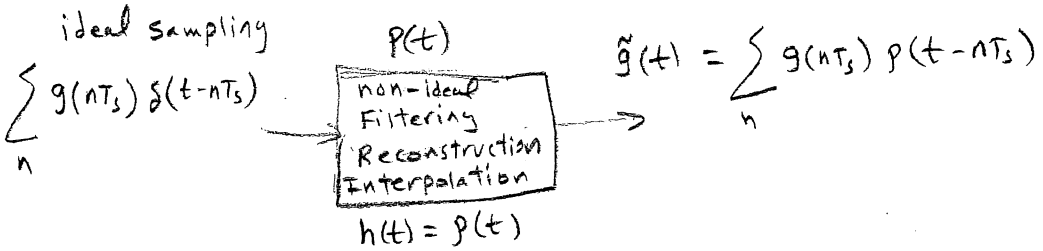


c)





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



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

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) $f_s = 1.22(2B) = 1.22(2\times 4.5\times 10^6) = 10.98\times 10^6$ samples/sec

b) 10 bits/sample

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

Channel BW $= \left(\#\text{ of pulse per seconds}\right) * 2 = 223.992$ MHz

$= 0.224$ GHz

Q6)

$$\frac{S_o}{N_q} = 3L^2\frac{\overline{m^2(t)}}{m_p^2} \xrightarrow{n_1=10} 30 = 3\left(2^{10}\right)^2\frac{\overline{m^2(t)}}{m_p^2} \Rightarrow \frac{\overline{m^2(t)}}{m_p^2} = 10/\left(2^{20}\right)$$

$$42 = 3L^2\left(\frac{\overline{m_2(t)}}{m_p^2}\right) \Rightarrow L^2 = \frac{42\times 2^{20}}{3\times 10} \Rightarrow L = 1211.61 \Rightarrow L = 1212$$

$n_2 = 11$ $\quad BW_1 = \frac{n_1 f_s}{2}$ $\quad BW_2 = \frac{n_2 f_s}{2}$ $\quad$ Fraction $= \frac{BW_2}{BW_1} * 10 = \frac{11}{10} = 1.1$

% increase $= 10\%$

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

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

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

$= 37.71\ dB$

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

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

$n = 8$ 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) DSI Carrier 1.544×10^6 bits/s $\Longrightarrow$ DSI = 4 Carriers

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

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

Q11) a) $|m(t)|_{max} < E f_s \Longrightarrow E = \frac{1.75\times10^4}{f_s}$

b) $N_0 = \frac{E^2 B}{3 f_s} = 1.02\times10^8\ B/f_s^3$