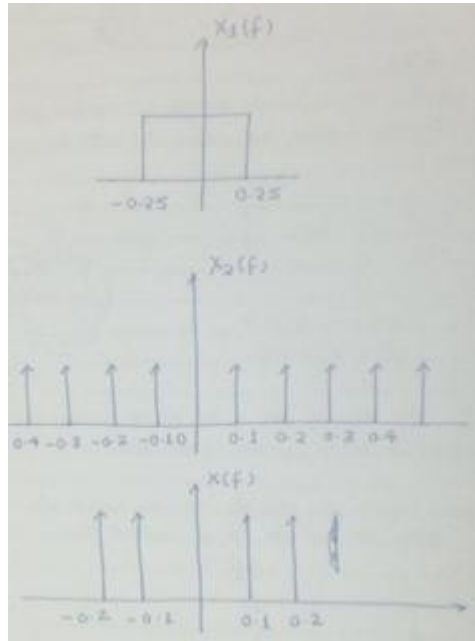


Communication Conventional Solution

Sol. 1(a) $S(t) = A_c A_m \cos(2\pi f_m t) \cos(2\pi f_c t) + (1 - 2\alpha) A_c A_m \sin(2\pi f_m t) \sin(2\pi f_c t)$

If $\alpha = 0.5$ then DSB-SC and $\alpha = 0$ or 1 then SSB-SC

Sol. 1(b) Let $x(t) = x_1(t) \otimes x_2(t)$



Sol. 1(c) For Noncoherent BFSK $E_b / N_o = 13\text{dB} = 19.95$

$$P_e = \frac{1}{2} \exp(-E_b / 2N_o) = \frac{1}{2} \exp\left(-\frac{19.95}{2}\right) = 2.32 \times 10^{-5}$$

Coherent FSK: $P_e = Q\left(\sqrt{\frac{2E_b}{N_o}}\right) = Q(\sqrt{2 \times 6.31}) = Q(\sqrt{12.66}) = \frac{1}{\sqrt{2\pi \times 12.6}} \cdot e^{-\frac{12.6}{2}} = 2.07 \times 10^{-4}$

where $\frac{E_b}{N_o} = 8\text{dB} = 6.31$ So Noncoherent FSK is preferred over coherent FSK.

Sol. 1(d)

1. For WBFM $M.I > 1$ and NBFM < 1
2. For WBFM maximum deviation is 75 KHz and for NBFM it is 5 KHz
3. For WBFM Range of modulating frequency is 30Hz-15KHz & 30Hz-3 KHz
4. For WBFM Bandwidth is 15 times in case of NBFM
5. Noise is better suppressed in WBFM than NBFM

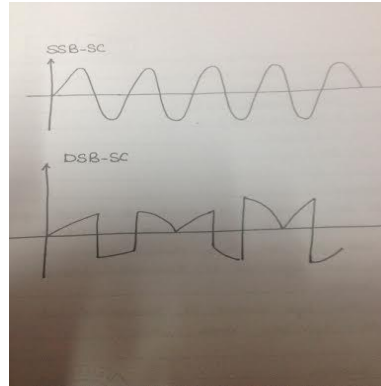
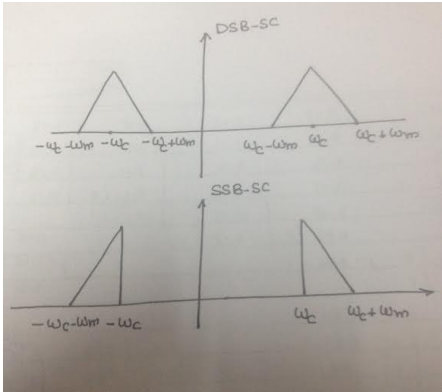
Sol. 2(a) $P_{sb}(\text{DSB-SC}) = \frac{m_a^2}{2} P_c = \frac{X^2}{4} P_x$

$$P_{sb}(\text{SSB-SC}) = \frac{X^2}{2} P_x$$

Sol. 2(b) $s(t) = a(K(v + A_c \cos \omega_c t))^2 - b(v - A_c \cos \omega_c t)^2$

For (DSB-SC) $K = \pm \sqrt{\frac{b}{a}}$

Sol. 2(c)



Sol. 3(a) (i) $f_b = \frac{(r+1)}{2} R_s$

$100 \text{ KHz} = \frac{1.6}{2} \times R_s$

$\therefore R_s = 125 \text{ K symbole / sec} = 125 \text{ kbps}$

(ii) $L = 32 = 2^5$

$R = 125 \text{ kbps} = 5 \text{ bits/symbol} \times f_s \frac{\text{samples}}{\text{symbol}}$

$f_s = \frac{125 \text{ kbps}}{5 \text{ bits / symbol}} = 25 \text{ k samples / sec}$

Bandwidth of analog $= \frac{f_s}{2} = 12.5 \text{ KHz}$

Sol. 3(b) Binary case: $R = 8000 \text{ samples / sec} \times 6 \text{ bits / sample} = 48000 \text{ bps}$

$W = \frac{1}{T_b} = R = 48,000 \text{ Hz}$

$(S/N) = 3L^2 = 3(64)^2 = 12,288$

$\approx 41 \text{ dB}$

4-Level Case: $R_s = \frac{48000 \text{ bps}}{2 \text{ bits/symbol}} = 24000 \text{ symbols/sec}$

$W = 1/T = R_s = 24000 \text{ Hz}$

$(S/N) = \text{same as in binary} = 48 \text{ dB}$

Sol. 4(a) Total bits detected in one day = $1000 \text{ bits/sec} \times 86400 \text{ sec/day}$

$$= 8.64 \times 10^7 \quad \text{So } P_B = \frac{100}{8.64 \times 10^7} = 1.16 \times 10^{-6}$$

$$P_B = Q\left(\sqrt{\frac{2E_b}{N_o}}\right) = Q\left(\sqrt{\frac{2 \times ST}{N_o}}\right)$$

$$\text{Here } S = 10^{-6} \text{ W} \text{ \& } T = \frac{1}{1000} \text{ sec}$$

$$P_B = Q\left(\sqrt{\frac{2 \times 10^{-6} \times 10^{-3}}{10^{-10}}}\right) = Q(\sqrt{20}) = Q(4.47) = 4.05 \times 10^{-6}$$

No it can't be preferred

Sol. 4(b) Phase deviation is 372.13° and Bandwidth = 44 KHz

$$\text{Sol. 4(c)} \quad H(f) = \frac{1 - e^{-j2\pi fT}}{j2\pi f} \Rightarrow h(t) = \text{sgn}(t) - \text{sgn}(t - T)$$

$$\text{Sol. 5(a)} \quad \% \text{ Modulation in FM} = \frac{\Delta f}{75} \times 100 = 80 \Rightarrow \Delta f = 60 \text{ KHz}$$

$$\% \text{ Modulation in TV} = \frac{\Delta f}{25} \times 100 = 80 \Rightarrow \Delta f = 20 \text{ KHz}$$

$$\text{Sol. 5(b)} \quad \frac{S}{N} = L^2 = 96 \text{ dB} \quad L = 63096$$

So number of Levels = 63096 so number of bits = 16 bits/sample

$$R = 16 \text{ bits/sample} \times 44.1 \text{ Ksamples/sec} = 705600 \text{ bps}$$

$$\text{Sol. 5(c)} \quad L = 2(R + h) \sin \cos^{-1}\left(\frac{R}{R + h}\right)$$

$$\text{Sol. 5(d)} \quad r_a + r_p = 2a = 40000 \text{ \& } \sqrt{r_a r_p} = 16000$$

So here Apogee = 32000 Km & perigee = 8000 Km

$$\text{Sol. 6(a)} \quad \frac{C_{\max}}{C_{\min}} = \left(\frac{f_{\max}}{f_{\min}}\right)^2$$

when $f_{LO} > f_s$

$$f_{\max} = 1600 + 455 = 2055 \text{ \& } f_{\min} = 540 + 455 = 995$$

$$\frac{C_{\max}}{C_{\min}} = 4.265$$

when $f_{LO} < f_s$

$$f_{\max} = 1600 - 455 = 1145 \text{ \& } f_{\min} = 540 - 455 = 85$$

$$\frac{C_{\max}}{C_{\min}} = 181.46$$

Sol. 6(b)

Main function of RF amplifier:

1. Image channel rejection
2. Also provides initial gain
3. Can improve sensitivity and SNR

Main function of IF amplifier:

1. Most of the gain is provided by IF only
2. It also provides sensitivity
3. Also provides adjacent channel selectivity

Sol. 6(c): $L=42$ Km

Power Budget

Let $P_s =$ source output power in dBm.

$P_r =$ Minimum received power in dBm.

$P_s - P_r =$ Power Margin + all losses

1. source to fiber coupling loss

$P_c(\text{dB}) = 2 \text{ dB}$ (typical value)

2. splice loss

$P_s(\text{dB}) =$ splice loss

3. fiber loss ($\alpha_{\text{dB}}L$)

4. fiber to detector coupling loss ($P_D(\text{dB})$)

Typical value of 0.2 dB.

$P_s - P_r = P_M + P_c + P_s + \alpha_{\text{dB}}L + P_D$

Sol. 7(a): $P_r = -17.98 \text{ dBm}$

Sol.7 (b) $\frac{C}{N} = \text{EIRP} + M - L_a + 228.6 = 100 + M - 20 \log 6000 - 20 \log 36000 + 228.6 - 0.9$
 $= 118.51 \text{ dB}$

Sol. 7(c): $\gamma = 2.0879$ & $\lambda > 1.1286 \mu\text{m}$

