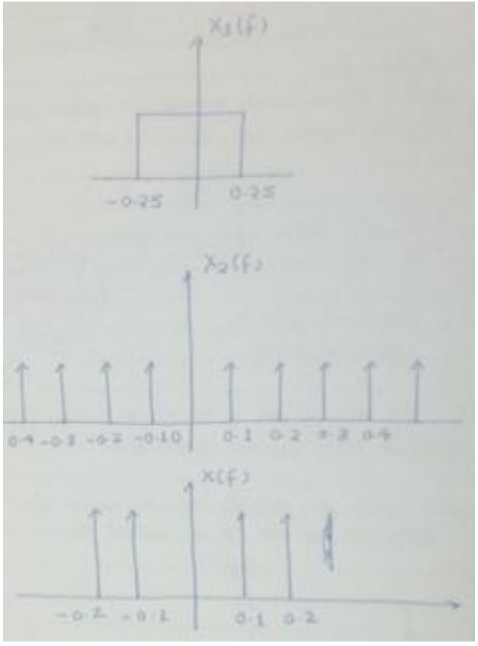
Communication Conventional Solution

Sol. 1(a) $S(t) = A_c A_m \text{Cos}(2\pi f_m t)\text{Cos}(2\pi f_c t) + (1-2\alpha)A_c A_m \text{Sin}(2\pi f_m t)\text{Sin}(2\pi f_c t)$

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 $E_b / N_o = 13\text{dB} = 19.95$

$$P_e = \frac{1}{2}\exp\left(-E_b / 2N_o\right) = \frac{1}{2}\exp\left(-\frac{19.95}{2}\right) = 2.32\times10^{-5}$$

Coherent FSK: $$P_e = Q\left(\sqrt{\frac{2E_b}{N_o}}\right) = Q\left(\sqrt{2\times6.31}\right) = Q\left(\sqrt{12.66}\right) = \frac{1}{\sqrt{2\pi\times12.6}}\cdot e^{-\frac{12.6}{2}} = 2.07\times10^{-4}$$

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

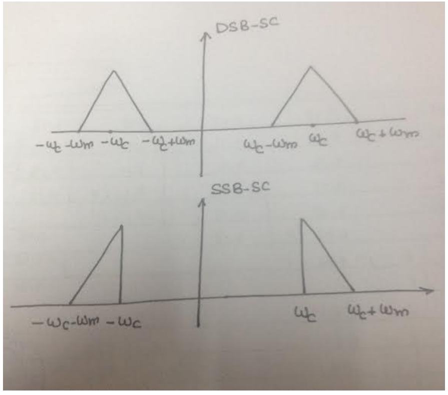
Sol. 2(a) $P_{sb}(\text{DSB}-\text{SC}) = \frac{{m_a}^2}{2}P_c = \frac{X^2}{4}P_x$

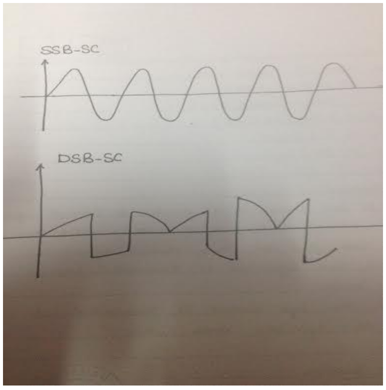
$$P_{sb}(\text{SSB}-\text{SC}) = \frac{X^2}{2}P_x$$

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) $K = \pm\sqrt{\dfrac{b}{a}}$

Sol. 2(c)





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

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

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

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

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

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

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

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: $R_s = \dfrac{48000\,\text{bps}}{2\,\text{bits/symbol}} = 24000$ symbols/sec

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

(S/N) = same as in binary = 48 dB

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

$$= 8.64\times10^{7} \quad \text{So} \quad p_B = \frac{100}{8.64\times10^{7}} = 1.16\times10^{-6}$$

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

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

$$P_B = Q\left(\sqrt{\frac{2\times10^{-6}\times10^{-3}}{10^{-10}}}\right) = Q\left(\sqrt{20}\right) = Q(4.47) = 4.05\times10^{-6}$$

No it can't be preferred

Sol. 4(b) Phase deviation is 372.13^{0} and Bandwidth= 44KHz

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

Sol. 5(a) $\%\ \text{Modulation in FM} = \dfrac{\Delta f}{75}\times100 = 80 \Rightarrow \Delta f = 60\,\text{KHz}$

$$\%\ \text{Modulation in TV} = \frac{\Delta f}{25}\times100 = 80 \Rightarrow \Delta f = 20\,\text{KHz}$$

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

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

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

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

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

So here Apogee= 32000Km & perigee= 8000Km

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

when $f_{LO} > f_s$

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

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

when $f_{LO} < f_s$

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

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

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 O/P power in dBm.

P_r = Minimum received power in dBm.

$\therefore P_S - P_r$ = Power Margin + all losses

1. Source to fiber coupling loss

$P_c(dB)$ = 2dB (typical value)

2. Splice loss

$P_s(dB)$ = splice loss

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

4. fiber to detector coupling loss $(P_D(dB))$

Typical value of 0.2 dB.

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

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): $\gamma = 2.0879\ \&\ \lambda > 1.1286\,\mu\text{m}$