Q.1

consider modulating signal $x(t) = A\sin(\omega t$

signal power $\sigma_x^2 = \frac{A^2}{2}$

noise power $\sigma_q^2 = \frac{\Delta^2}{12}$

$$SNR_q = \frac{\sigma_x^2}{\sigma_q^2} = \frac{6A^2}{\Delta^2}$$

since $\Delta = \frac{2A}{L}$

$$SNR_q = \frac{6A^2 \cdot L^2}{4A^2} = 1.5L^2$$

$$SNR_q(dB) = 10\log 1.5 + 10\log L^2$$

$$SNR_q(dB) = 1.76 + 20\log L$$

Q2

B.W. $= 4.5$ MHz

N.R. $= 2 \times 4.5 = 9$ MHz

sampling rate $= 9 + \frac{20 \times 9}{100} = 10.8$ MHz

$L = 1024$

$2^n = 1024 \Rightarrow n = 10$

10 binary pulses required to encode each signal.

pulse rate $= nf_s = 10 \times 10.8 = 108$ Mbps.

minimum B.W. $= \frac{nf_s}{2} = \frac{108}{2} = 54$ MHz

Q.3 $f_m = 4\text{ kHz}$, $f_s = 2\times 4 = 8\text{ kHz}$

$V_{p\text{-}p} = 2V_m = 2\times 3.8 = 7.6\text{ V}$

$S_i = 30\text{ mW}$

Required SNR(dB) = 20 dB

$\text{SNR} = 100$

$$\frac{S_i}{N_q} = 100 \Rightarrow N_q = 0.3\text{ mW}$$

since $N_q = \frac{\Delta^2}{12} = 0.3\text{ mW}$

$$\Rightarrow \Delta^2 = 3.6\times 10^{-3}$$

$$\Delta = 0.06$$

$$\Delta = \frac{V_{p\text{-}p}}{L} \Rightarrow \frac{7.6}{L} = 0.06$$

$$\Rightarrow L = 126.6 \simeq 127$$

$$L = 2^n \simeq 127$$

$$n = 7$$

7 bits are needed per sample.

- minimum B.W. $= \frac{n f_s N}{2} = \frac{7\times 8\times 30}{2} = 840\text{ kHz}$

Q.4. $f_m = 4\text{ kHz}$

$f_s = 1.25\times 2\times 4 = 10\text{ kHz}$

error $\frac{\Delta}{2} = \frac{0.2\times V_m}{100}$

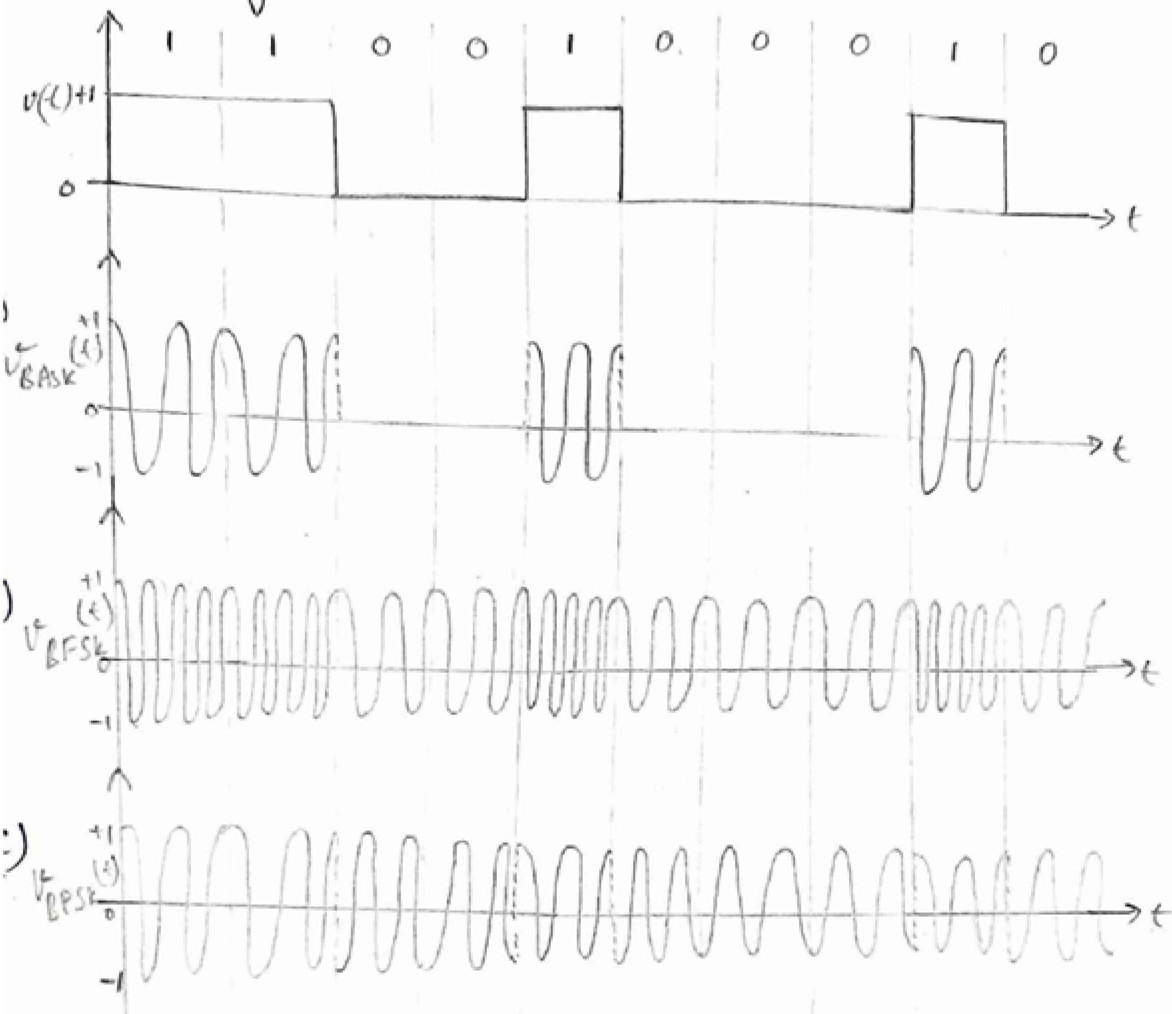
$L = \frac{2V_m}{\Delta} = \frac{100}{0.2} = 500$

$\Rightarrow 2^n = 500 \Rightarrow n = 9$

- Transmission rate $= n f_s = 90\text{ kbps}$
- B.W. $= \frac{n f_s}{2} = 45\text{ kHz}$
- if $N = 25$

B.W. $= \frac{n f_s N}{2} = \frac{25\times 90}{2} = 1125\text{ kHz}$

Sol^n 5 Binary seq (1100100010)



Sol^n $R_b = 10$ kbps

Min. Bandwidth $= R_b = 10$ kHz

Sol.

$f_m = 49$ kHz , $f_s = 51$ kHz $f_b = 2$ kbps

Peak frequency $\Delta f = |(f_m - f_s)|/2$

$= \left|\frac{-2}{2}\right|$ kHz $= 1$ kHz

Min. Bandwidth $= 2(\Delta f + f_b)$

$= 2(1000 + 2000) = 6$ kHz

Sol^n : $R_b = 10$ M bps

min B.W $= R_b = 10$ MHz

sol^n : For Delta modulator

Pulse rate = Sampling rate

$r = f_s$ $\because n=1$

So $f_s = 1000$ samples/sec.

$$\Delta_{opt} = \left.\frac{d\,m(t)}{dt}\right|_{max} \cdot \frac{1}{f_s}$$

$$= \frac{10}{1000}$$

$\Delta_{opt} = 10$ mV

sol^n :) $m(t) = 6\sin(2\pi \times 10^3)t + 4\sin(4\pi \times 10^3)t$

Step size $\Delta = 0.314$ V

$$\frac{\Delta}{T_s} \geq \left.\frac{d\,m(t)}{dt}\right|_{max}$$

$$\frac{\Delta}{T_s} \geq (12\pi + 16\pi)10^3$$

$$\Delta f_s \geq 28\pi \times 10^3$$

$$0.314\, f_s \geq 28\pi \times 10^3$$

$$\frac{\cancel{\pi}}{10} f_s \geq 28\, \cancel{\pi} \times 10^3$$

$$f_s \geq 280 \text{ KHz}$$