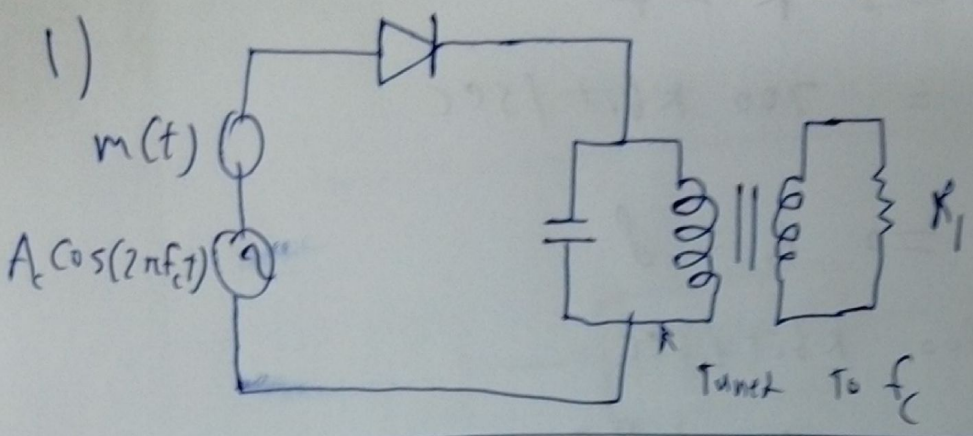
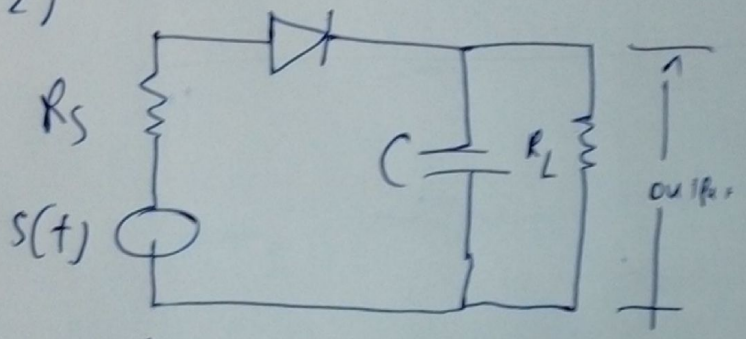
Question 1 :-

1)

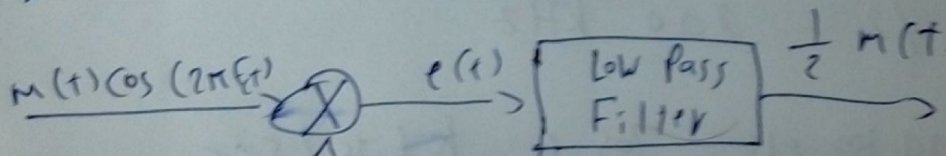


2)



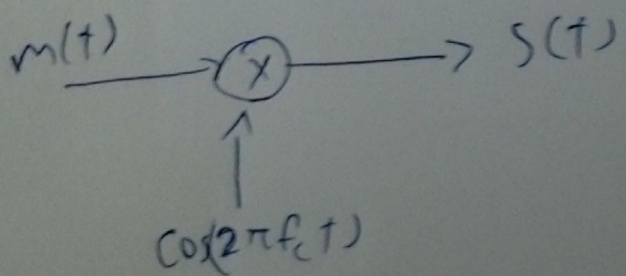
$$\frac{1}{f_c} < RC < \frac{1}{W}$$

3) DSB-SC Coherent Modulator :-

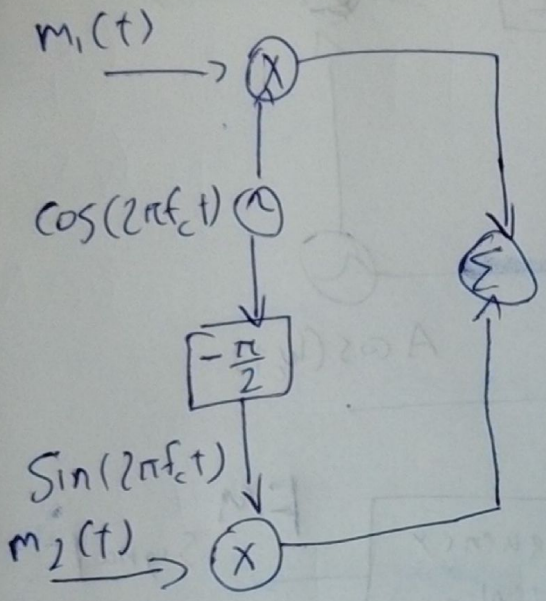


$$LPF\{e(t)\} = \frac{1}{2} m(t) \cos(\Delta\omega t + \phi)$$

a) DSB-SC modulator



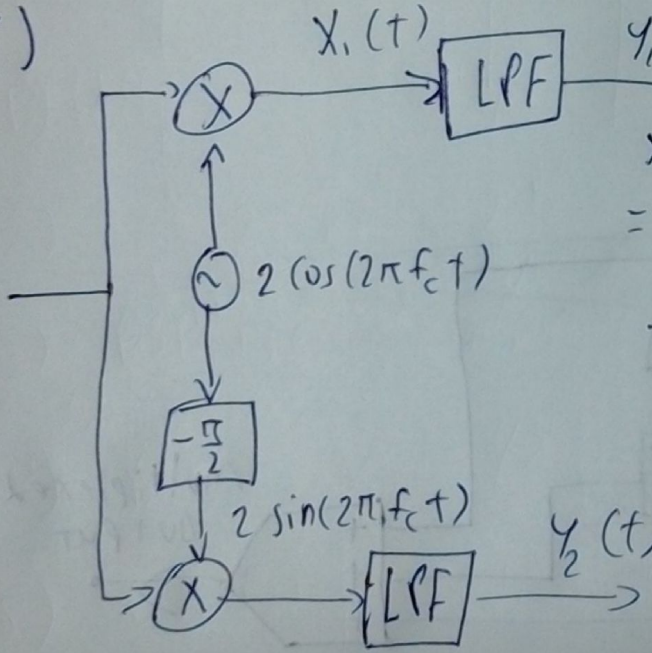
5) DSB - QAM



$$S_c(t) = m_1(t)\cos(\omega_c t) + m_2(t)\sin(\omega_c t)$$

---

6)



$$X_1(t) = 2 S_c(t)\cos(\omega_c t)$$

$$= 2m_1(t)\cos^2(\omega_c t) + 2m_2(t)\sin(\omega_c t)\cos(\omega_c t)$$

$$= m_1(t)\left[1 + \cos(2\omega_c t)\right] + m_2(t)\sin(2\omega_c t)$$

$$y_1(t) = LPF\{X_1(t)\}$$

$$= m_1(t)$$

$X_2(t)$ The same but $\sin(\omega_c t)$

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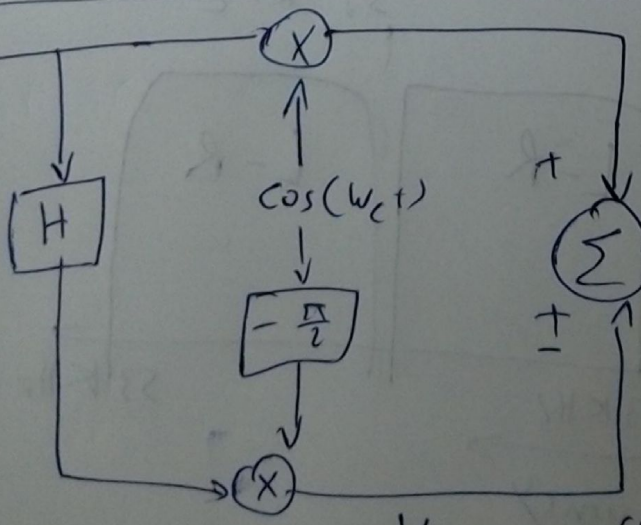
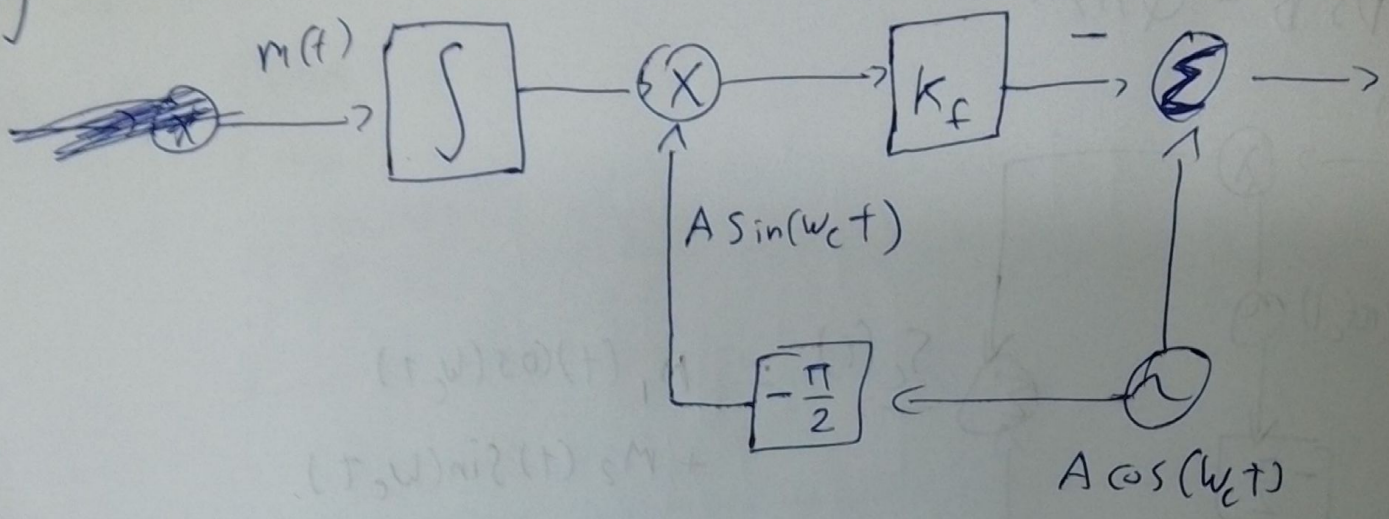
7)



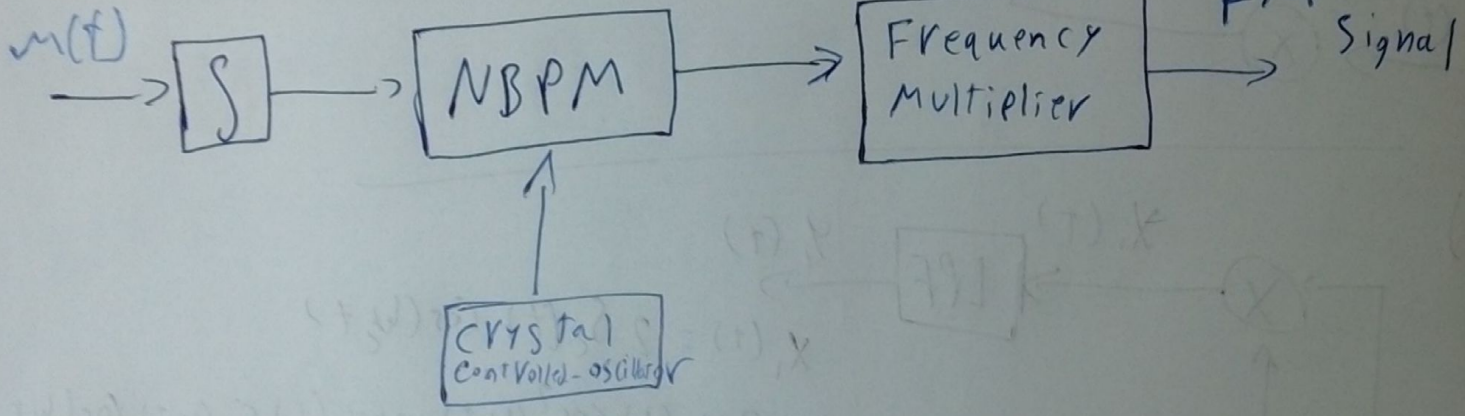
$$y_{LSB}(t) = m(t)\cos(\omega_c t) + \hat{m}(t)\sin(\omega_c t)$$

$$y_{USB} = m(t)\cos(\omega_c t) - \hat{m}(t)\sin(\omega_c t)$$

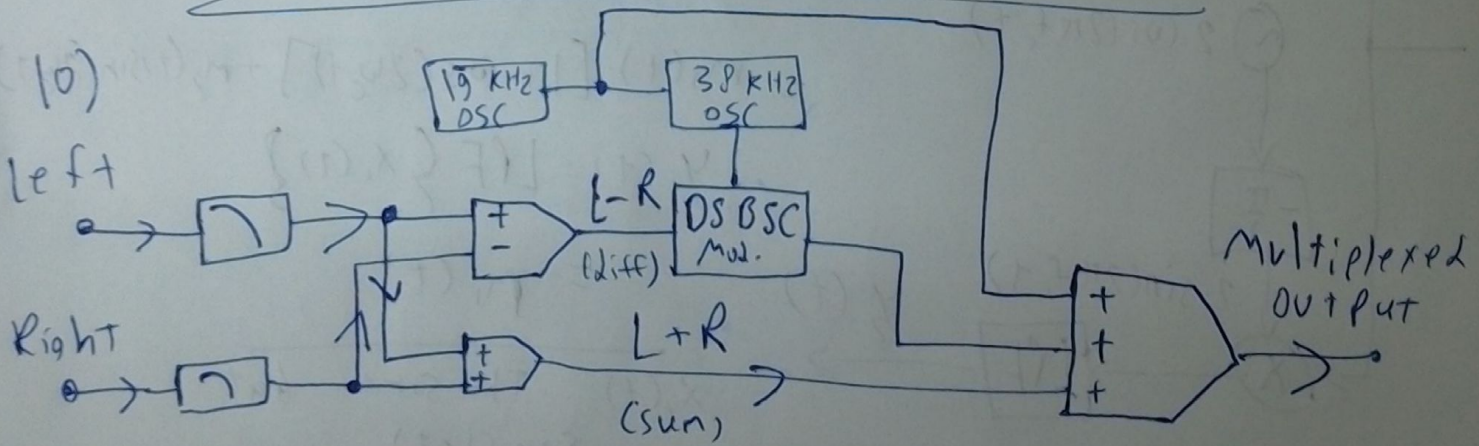
8)

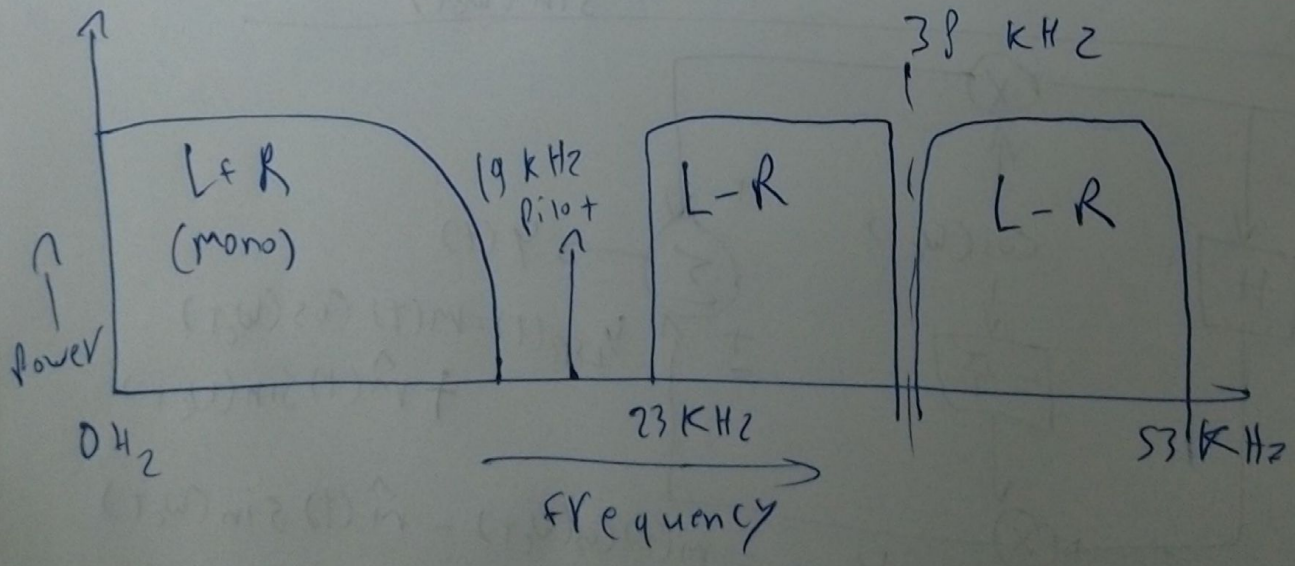


9)

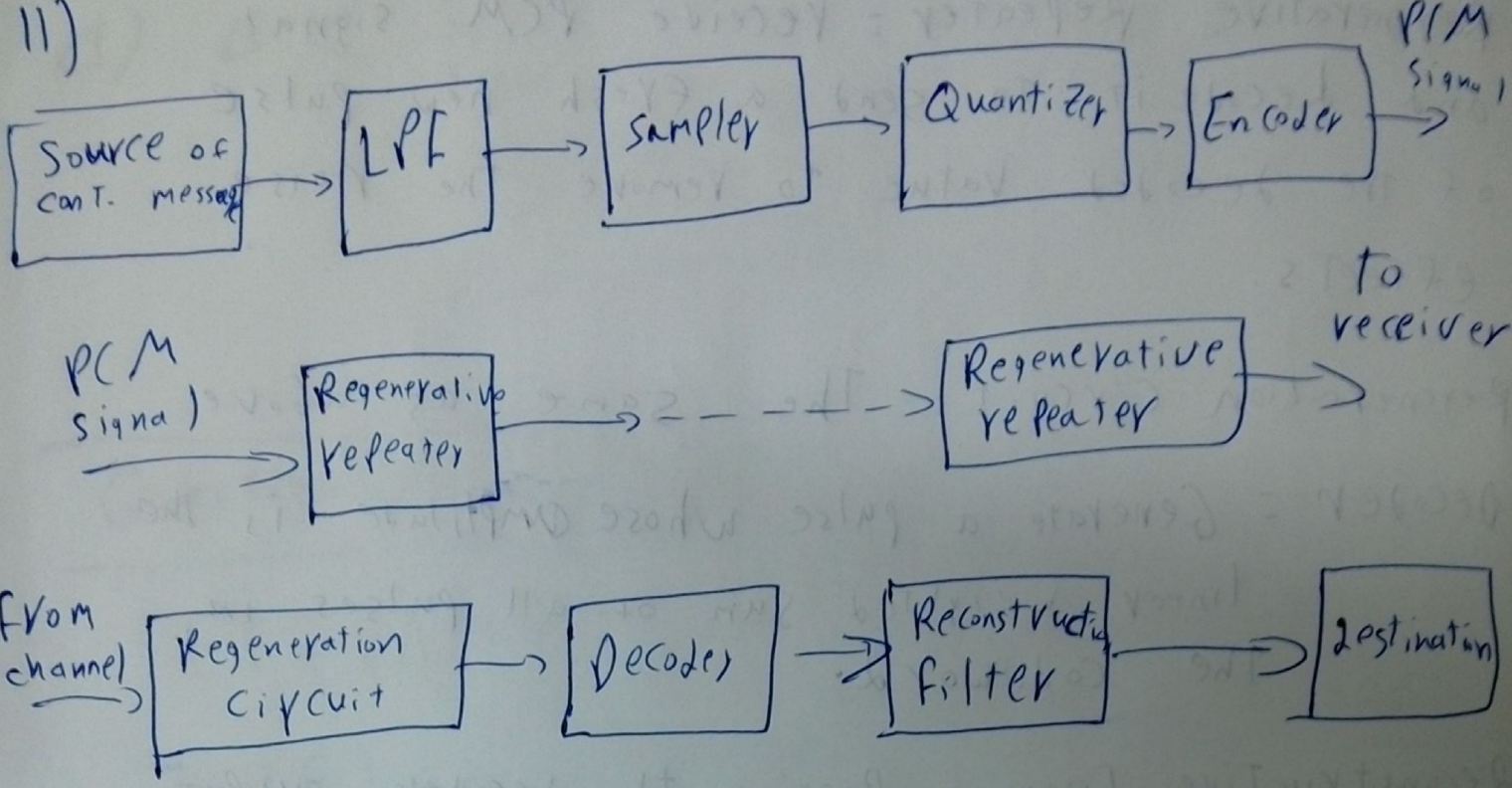


10)





11)



LPF = Remove high frequency components from the message.

Sampler = Transform $m(t)$ into discrete analog signal by taking samples at rate f_s higher than or equal twice the highest frequency component W in $m(t)$

Quantizer = Transform the sampled message to discrete amplitude message (finite set of possible amplitudes)

Encoder = Convert the Quantized message to more robust and suitable form to transmit. (Binary code)

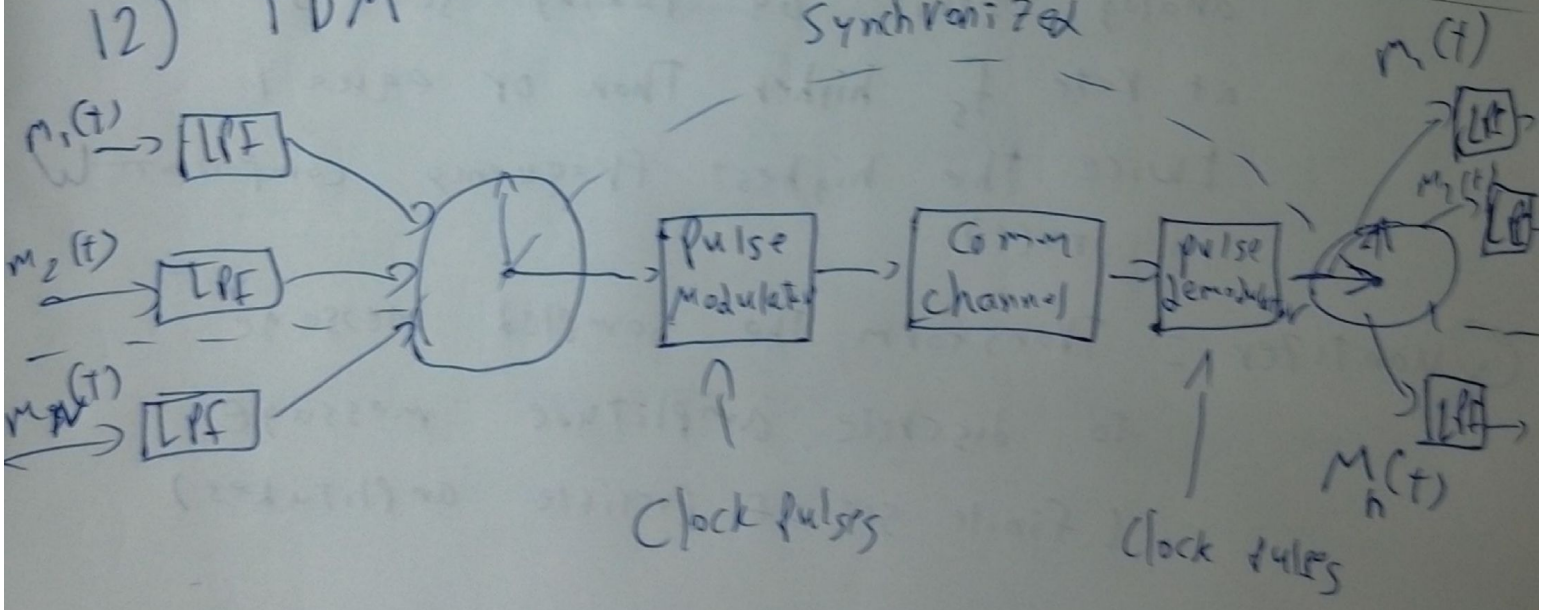
Regenerative Repeater = receive PCM signal and decode it to send a fresh new pulse of the decoded value to remove the noise effects.

Regeneration Circuit = The same as above.

Decoder = Generate a pulse whose amplitude is the linear weighted sum of all pulses in the codeword.

Reconstructive Filter = Passing the decoder output through a LPF with cutoff frequency equal to the message bandwidth

12) TDM



Question 2 :-

$$s(t) = 2\cos(\omega_c t + 0.1\cos(200t))$$

1) $P = \frac{1}{2} A_c^2 = \frac{1}{2} * 2^2 = 2$ watt

2) $\phi(t) = \omega_c t + 0.1\cos(200t)$

$$f_i = \frac{1}{2\pi}(\omega_c + 20\sin(200t))$$

$$f_{max} = \frac{1}{2\pi}(2\pi f_c + 20) = f_c + \frac{20}{2\pi}$$

$$\Delta f = 10/\pi$$

3) $\beta = \frac{\Delta f}{f_m} = \frac{\frac{10}{\pi}}{\frac{200}{2\pi}} = 0.1$

Question 3 :-

1) $\Delta = \frac{2M_p}{L}$

$$\text{Max Error} = \frac{\Delta x}{2} = \frac{2M_p}{2L} = 0.4 \quad \therefore L = \frac{5}{0.4} = 12.5$$

Round to nearest power of 2 $\boxed{L = 16}$

2) Max Error $= \frac{\Delta}{2} = \frac{\frac{2*5}{16}}{2} = 0.3125$ Volts

3) $L = \frac{5}{0.3} = 16.6667 \approx 32$

$$\text{max Error} = \frac{\Delta}{2} = \frac{\frac{2*5}{32}}{2} = 0.15625 \text{ Volts}$$

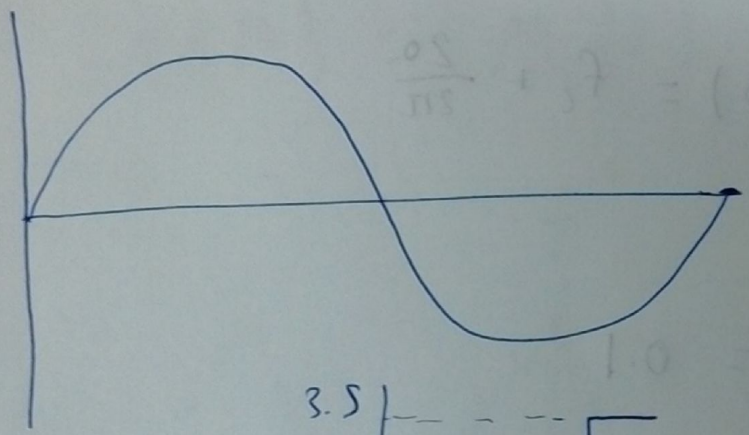
Question 4 :-

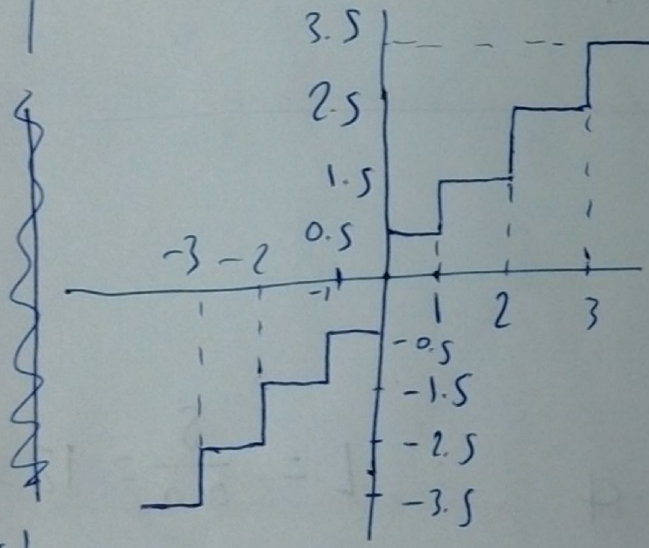
Bit rate = 50×10^6

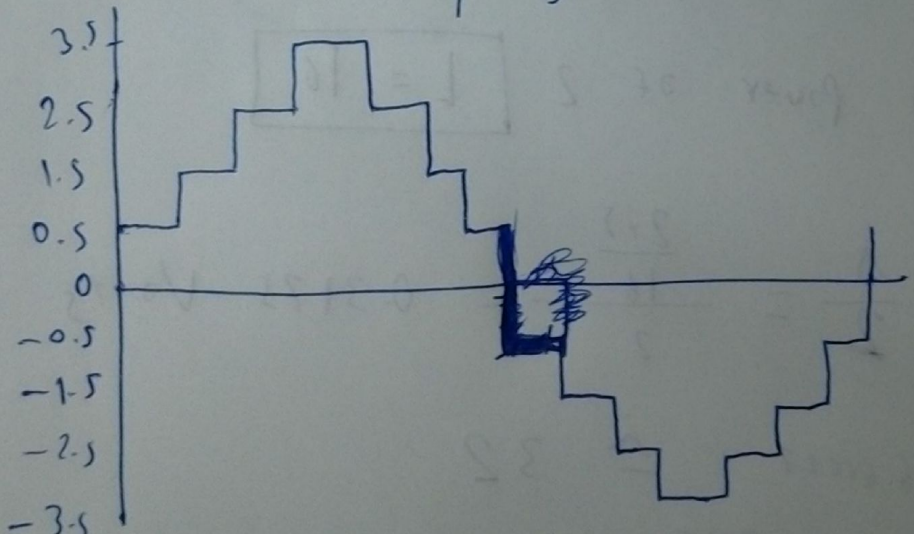
B.W = 25×10^6 = 25 MHz

Question 5 :-

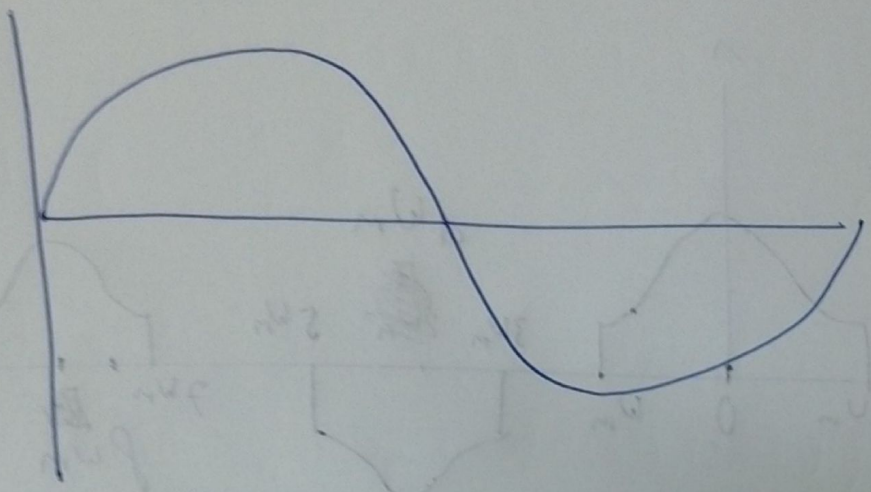
2)

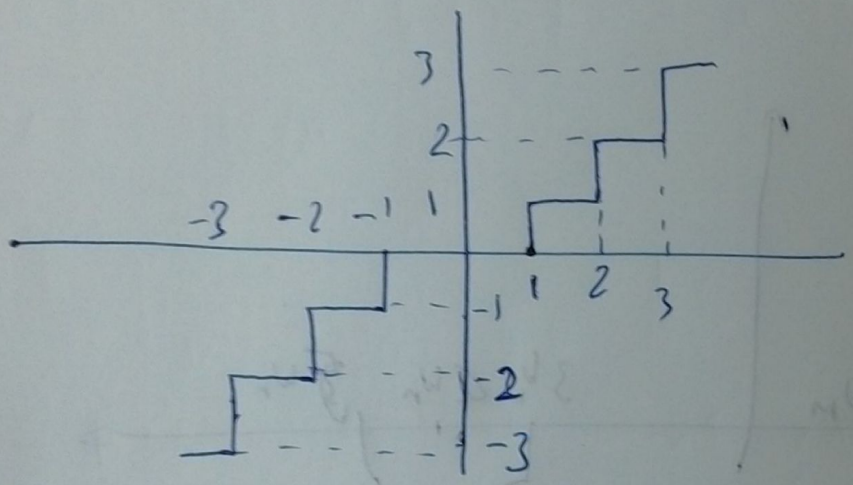


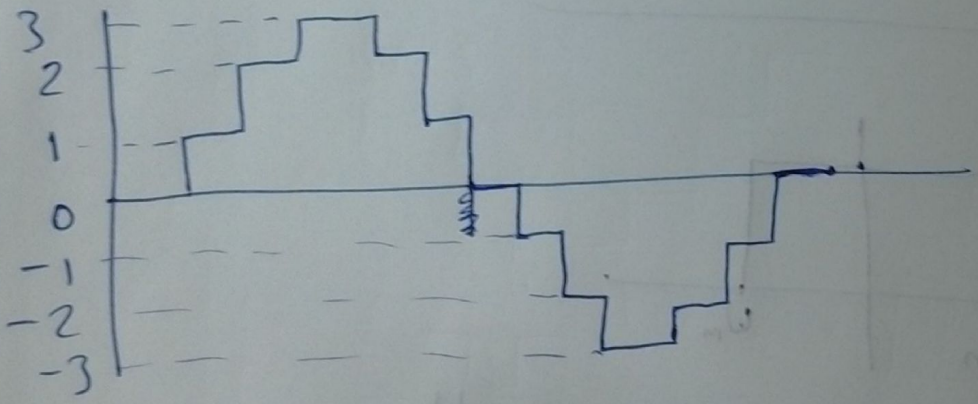




1)



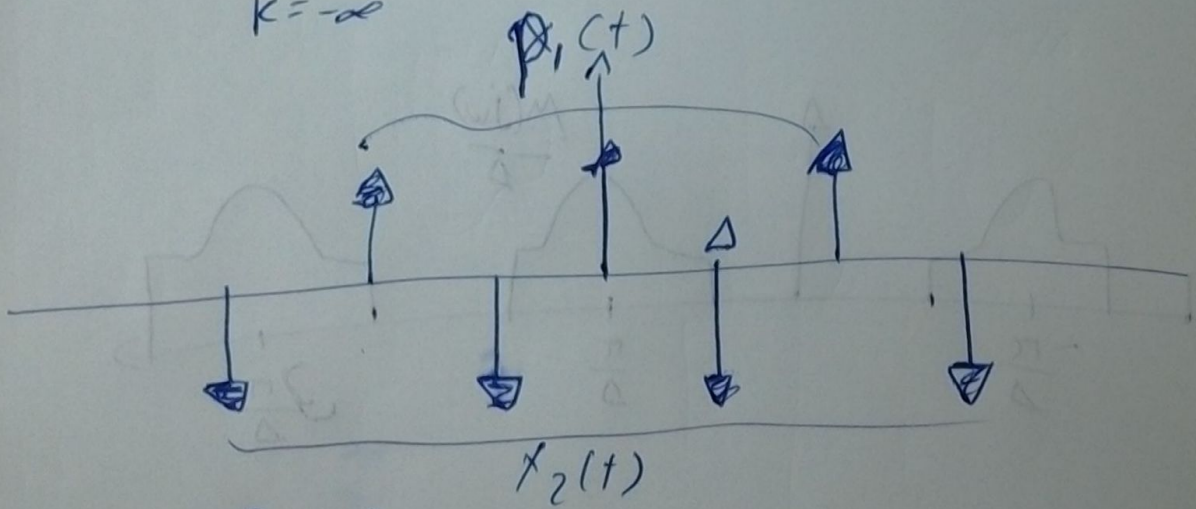




Question 6 :-

For periodic functions

$$FT = \sum_{k=-\infty}^{\infty} 2\pi a_k \delta(\omega - k\omega_m)$$



For $x_1(t)$

$$a_k = \frac{1}{T} = \frac{1}{2\Delta}$$

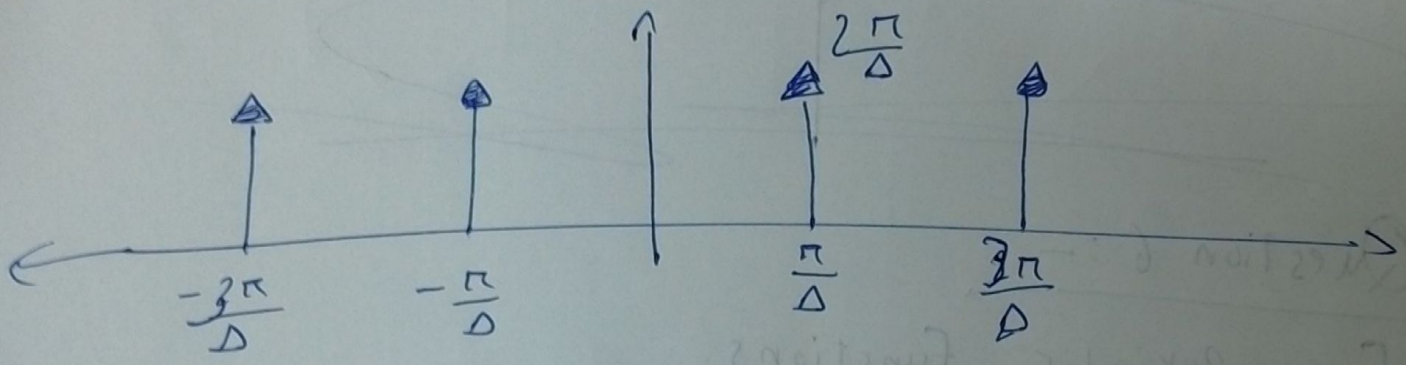
$x_2(t)$ is $x_1(t)$ shifted in time by Δ and multiplied by (-1)

$$b_k = a_k \cdot e^{-jk\frac{\Delta \cdot 2\pi}{2\Delta}} - 1$$

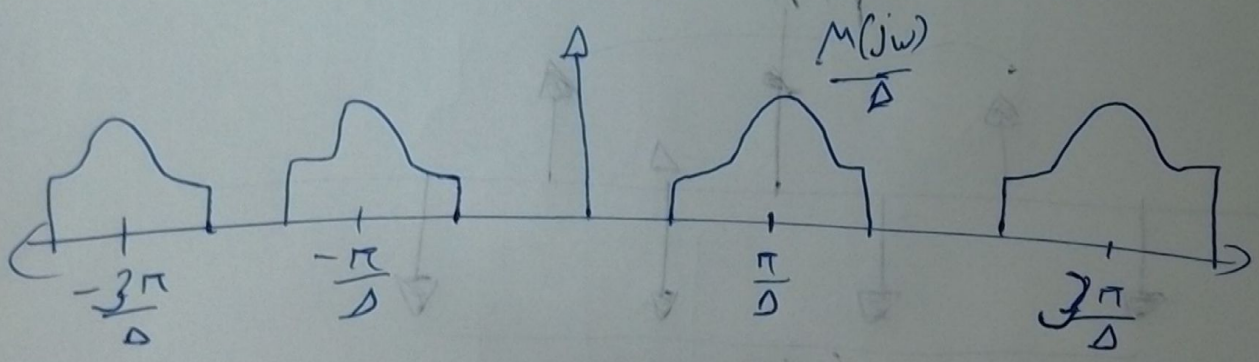
$$= \frac{-1}{2\Delta} e^{-j\pi k}$$

$$C_k = a_k + b_k = \frac{1}{2\Delta}\left(1 - (-1)^k\right)$$

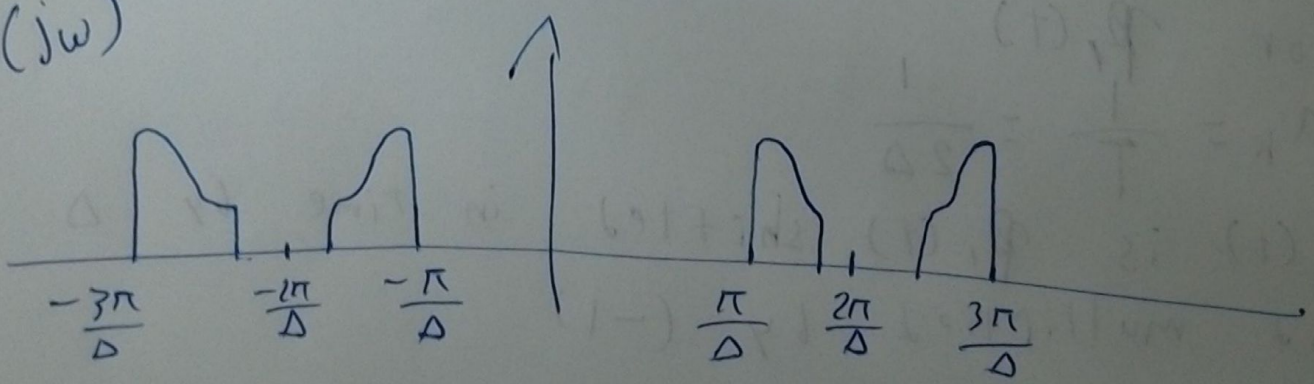
$$X_p(j\omega) = \sum_{k=-\infty}^{\infty} \frac{\pi}{\Delta} \delta\left(\omega - \frac{k\pi}{\Delta}\right)\left(1 - (-1)^k\right)$$



$X_p(j\omega)$



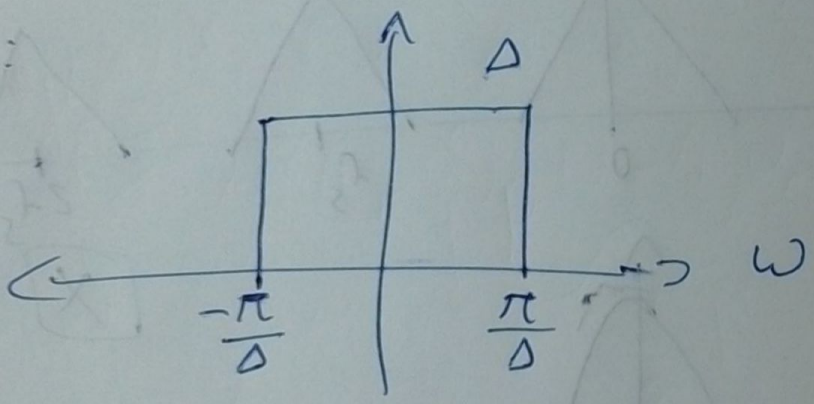
$Y(j\omega)$



2) $x_p(t)$ → (×) → LPF → $x(t)$

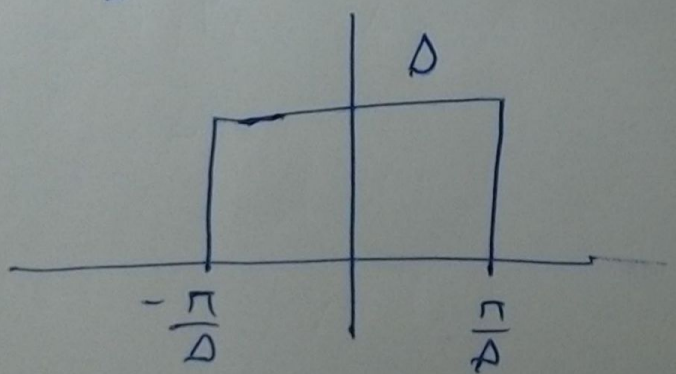
$\cos\left(\frac{\pi}{\Delta}\right)$

LPF :



3) $y(t)$ → (×) → LPF → $x(t)$

$\cos\left(\frac{\pi}{\Delta}\right)$



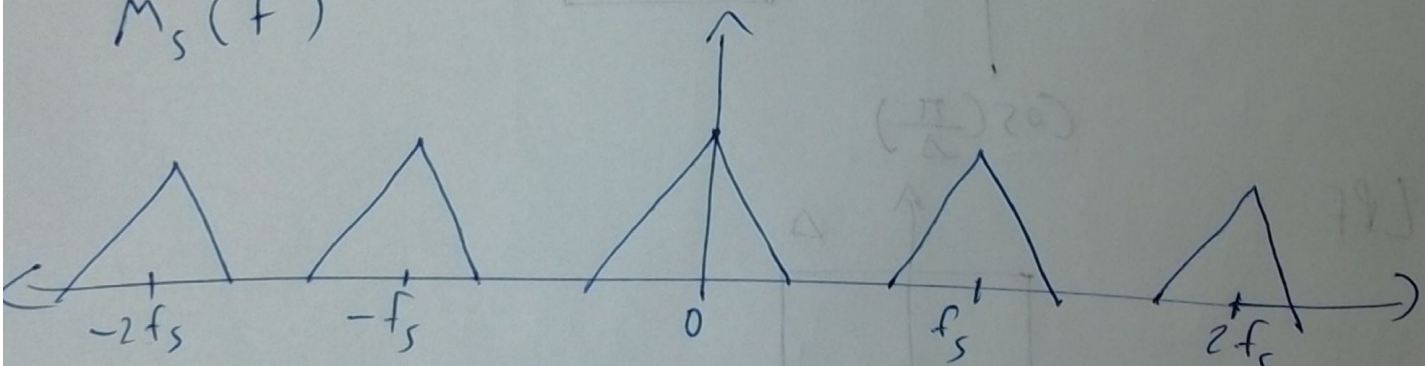
d) $\Delta < \frac{2\pi}{2\omega_m}$

$$\Delta < \frac{\pi}{\omega_m}$$

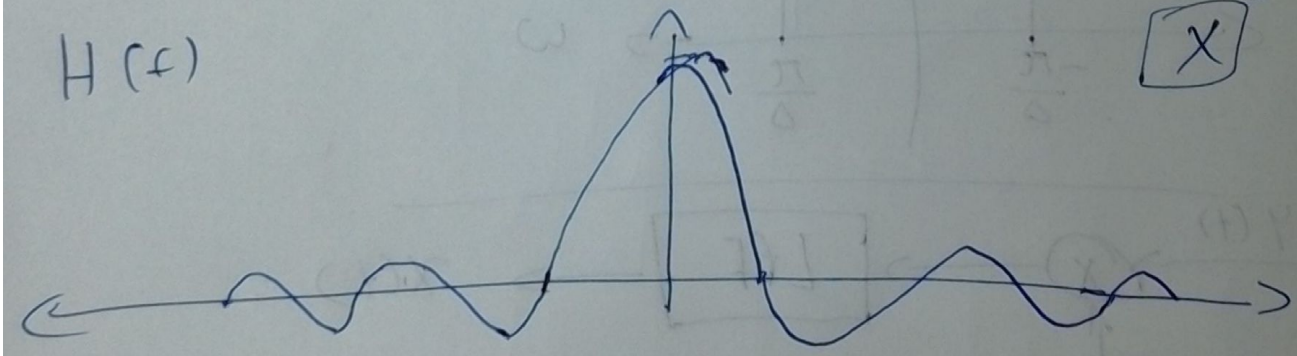
Question 7 :—

$$FT\{PAM\} = M_s(f) \cdot H(f)$$

$M_s(F)$



$H(f)$



X