Department of Electrical Engineering
Final Assignment Summer 2020
Subject: Communication Systems

Max Marks: 50

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Question 1 (10)

A signal x(t) band limited by 250 Hz is sampled by an impulse train with angular frequency of f_s

a. Determine the Nyquist rate required for perfect reconstruction of signal.
b. Considering x(t) and impulse train in figure below, construct all the signals involved in sampling.
c. Determine the cut off frequency of reconstruction filter H(f) to be used for the signal given in question.
d. If the frequency of sampler is $f_s \; 800Hz$, draw the resulting sampled signal s(f)

Question 2 (10)

a. Let $x(t)$ be a signal with Nyquist rate f_s determine the Nyquist rate for following
   i. $x(t) \;\; x(t \;\; 1)$
   ii. $dx(t) / dt$
b. Let $m(t) \;\; 10 \sin 400 \;\; t$ is sampled at 300Hz and reconstructed using an ideal low pass filter with a cut off frequency of 150Hz. What are the frequency/frequencies present in the reconstructed signal $y(t)$

Question 3 (15)

Consider the bit sequence (0 1 1 0 1 1 0 0 0 1 1) and draw the PCM waveform for following modulation schemes

a. NRZ-S
b. Polar-RZ
c. Split Phase Manchester
d. Bi-ϕ-L
e. Dicode - NRZ

Question 4 (15)

a. A carrier wave is represented by the equation $e_c(t)\ 7.5\sin 20\ 10^3\, t$. If the modulation index of wave is 0.5, draw the waveform of AM modulated waveform.

b. A sinusoidal carrier $10\cos 50\ 10^{5} t$ is amplitude modulated by the sinusoidal voltage of

$\cos 628 \quad 10^{3} t$ over a load resistance of 50

a. Find the depth of modulation and calculate the transmission efficiency
b. Plot the AM wave in time domain as well as its frequency domain spectrum
c. Calculate the total power in spectrum
d. Calculate the percentage power in USB

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Q No. 1.

Given data.

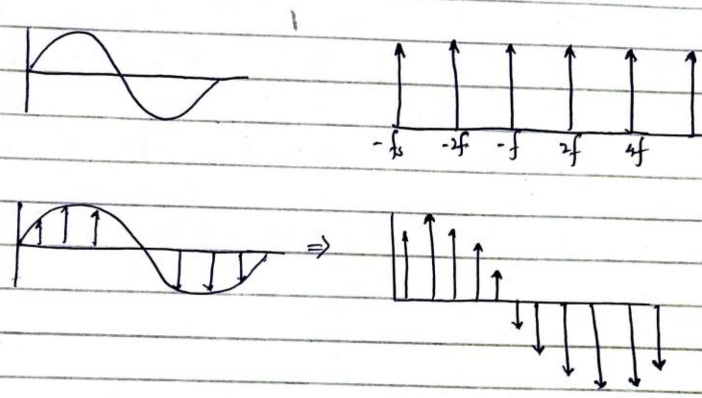
$f_m = 250\ Hz$

a) Nyquist Rate.

$N_R > 2f_m$.

$= 2 \times 250 = 500\ Hz$.

b)

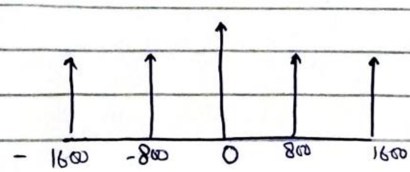


c) Cut off frequency.

$$f_c = \frac{1}{2\pi f_c R}$$

$$f_c = \frac{1}{2(3.14)\,500} = 3.184 \times 10^{-4}.$$

d) $f_s = 800\ Hz$.



Q No 2

a:- $x(t) + x(t-1)$

Sol:-

Nyquist rate = 2x maximum signal frequency

⇒ Sampling rate unt exceed nyquist rate in order to be able to fully Reconstruction the signal

a) $y(t) = x(t) + x(t-1)$

Fourier transform $y(j\omega) = j\omega x(j\omega)$

The Max frequiny for $y(j\omega)$

The min frequny is $y(j\omega)$

is the same as $x(j\omega)$ then $y(t)$ Nyquist

ii) $y(t) = x^2(t)$

we can re write the above fourier trasfom $y(j\omega) = j\omega x(j\omega)$

The Max frequy is $y(j\omega)$ is the same as $x(j\omega)$ thun $y(t)$ Nyquist rate is ω_0.

Q No 2

b:-

Sol

$m(t) = 10 \sin 400\pi t$

$$F_M = \frac{\omega_m}{2\pi} = \frac{400\pi}{2\pi} = 200 Hz$$

Frequency component of $y(t)$

first we calculate sample frequency by formula

$nfs + Fm$

put different values of n

$n = 0$

$fs = {}^{1}fm = 0 \pm Fm = \pm fm = \pm 200 Hz$

$n = 1$

$$Fs + Fm = \begin{cases} Fs + Fm \quad -300 + 200 = 100 Hz \\ Fs - Fm \quad -300 - 200 = 500 Hz \end{cases}$$

The cutt of frequency is 150 Hz So The frequency range from -150 Hz to +150 Hz will be pass

So frequency 100 Hz and -100 Hz is the range So 100 Hz will be compoment output.

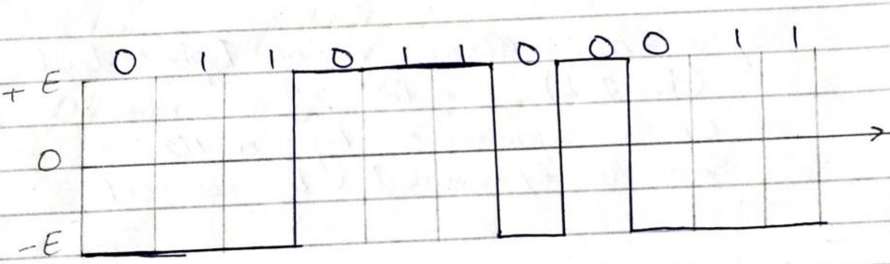
QNo3:- Consider the bit sequence (0110110001l) and draw the PCM waveform for the following Modulation schemes.

a) NRZ-S
b) Polar-RZ
c) Split phase Manchester
d) Bi-φ-L
e) Dicode-NRZ

Answer

a:-

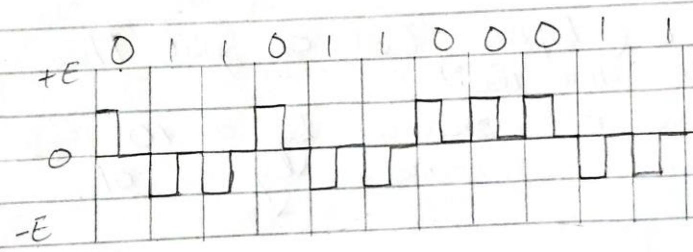
NRZ-S



NRZ S

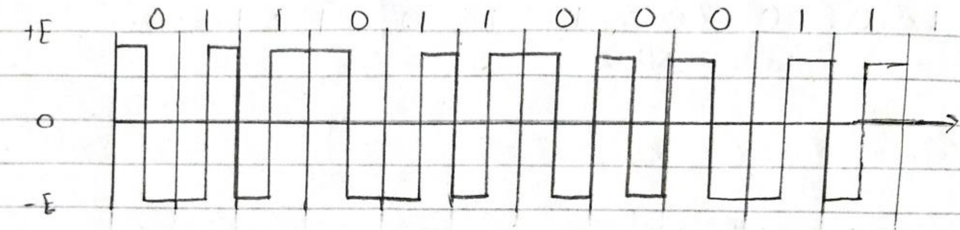
* "One" is represented by a no Change in level.
* "Zero" is represented by change in level.

b) Polar-RZ



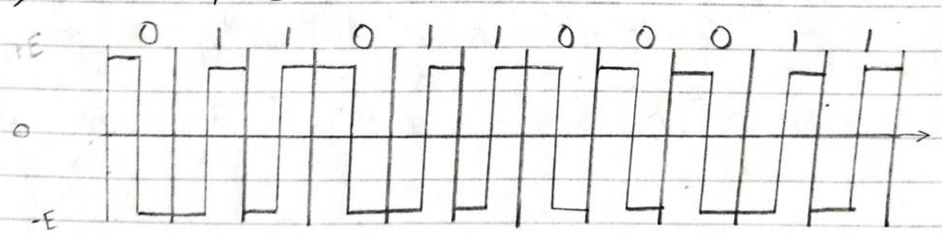
One and Zero are represented by opposite level polar pulses that are one half-bit in width.

c). Split Phase Manchester.



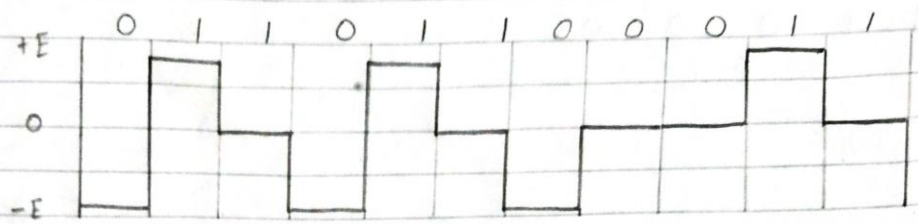
Split Phase Manchester or Biphase Level (Bi - Ø-L). 11 + 180°.
One is represented by a 10
Zero is represented by a 01.

D). Bi - Ø - L.



Bi - Ø - L (Biphase Level or Split Phase Manchester 11 + 180°)
One is represented by a 10
Zero is represented by a 01.

e). Dicode - NRZ.



Dicode - NRZ

- A 'one' to 'zero' or 'zero' to 'one' changes polarity.
- Otherwise a 'zero' is sent.

Q No 4 9:

Sol $e_c(t) = 7.5 \sin 20\times10^3 \pi t$

E_M [redacted] $= 0.5$

Draw AM Modulation wave form

So let us evaluate Em from Ec

$$m = E_m / E_c$$

There fore

$$E_m = m \times E_c = 0.5 \times 7.5 \sin 20 \times 10^3 \pi t$$

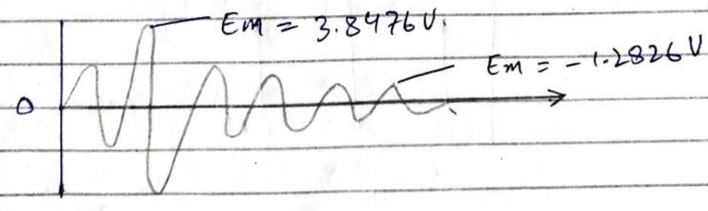
$$E_{Max} = E_c + E_M = 3.8476V$$

$$E_{min} = E_c - E_M = 1.2826V$$

AM Modulation:

The AM wave for $m = 0.5$ has shown in fig.

$$E_{max} = 3.8476\ V$$



Q no. 4.

b)

a) Depth of modulation.

$$m = \frac{E_m}{E_c}$$

$$m = \frac{10v}{5v}$$

$$m = 2v.$$

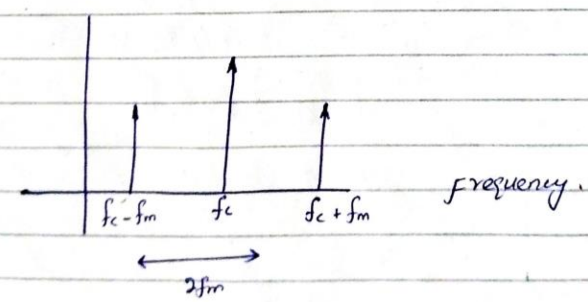
Transmission efficency

$$t_f = \frac{m^2}{2+m^2}$$

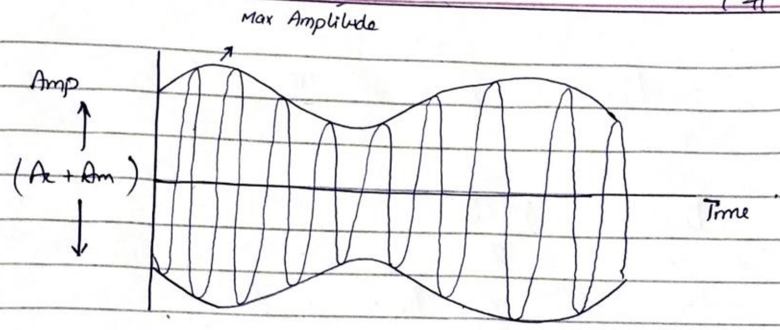
$$= \frac{(2)^2}{2+2^2}$$

$$t_f = \frac{4}{6} = \frac{2}{3}$$

b).



Amplitude frequency.



C. Power in Specturm:-

$$P_c = \frac{E_c^2}{2 * R}$$

$$= \frac{(5)^2}{2 \times 50} = \frac{25}{100}$$

$$P_c = 1/4$$

Total Power.

$$P_t \left(1 + \frac{m^2}{2}\right) P_c.$$

$$= \left(1 + \frac{(2)^2}{2}\right) \times 0.2$$

$$= \left(1 + \frac{4}{2}\right) 0.2$$

$$= (3)\ 0.2$$

$$P_t = 0.6$$

d) : Percentage Power in USB.

$$P_{USB} = \frac{m^2 E_c^2}{8}.$$

$$= \frac{m^2}{4} P_c.$$

$$= \frac{(2)^2}{4} \times 0.6$$

$$= 4/4 \times 0.6$$

$$P_{USB} = 0.6$$