IQRA NATIONAL UNIVERSITY

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Subject: Communication Systems

Question 1 (10)

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

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 800 s f Hz , draw the resulting sampled signal s(f)

Date (1)

QUESTION 1 :-

a, Nyquist rate requried for a signal:-

Solution :-

As we know nyquist rate =>
$f_s \geq 2f_m$,

$f_m = 250\ Hz$

So

$f_s \geq = 2 \times 250\ Hz$

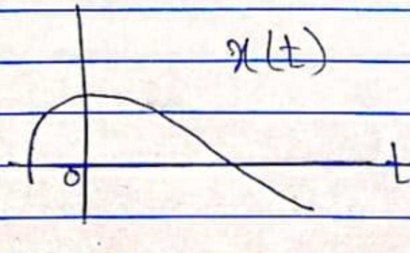
$f_s \geq = 500\ Hz$

Nyquist rate = 500 Hz

Now,

b,

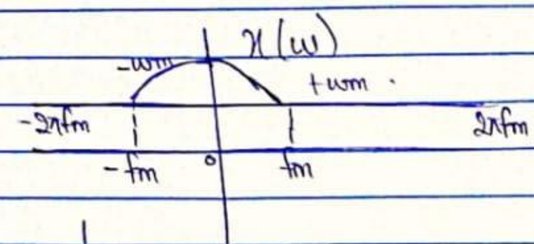
$x(t) =$



If we take fourier transform of signal.

Date (2)

So,



Spectrum of continous signal

$W_m = \frac{2\pi}{T_s}$

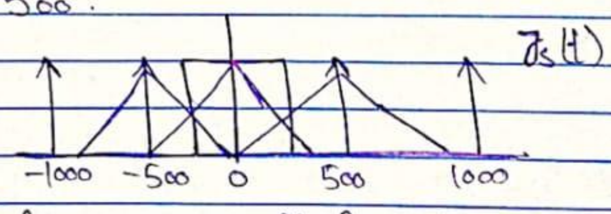
T_s shows impulse train.

$T_s = \frac{1}{f_s}$

$= \frac{1}{500}$

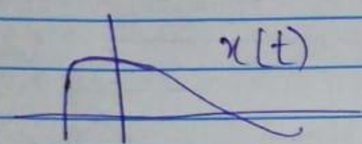
$= 0.002$

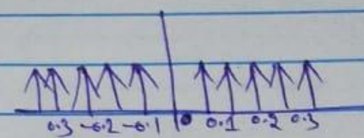
As $f_s = 500$.



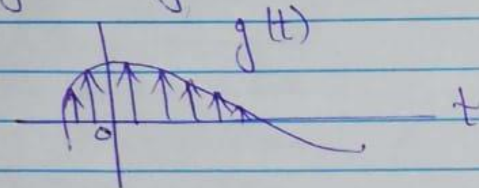
Now if we multiply the $x(t)$ and $\delta_s(t)$ we get sampling signal.

Date (3)





Sampling signal:-

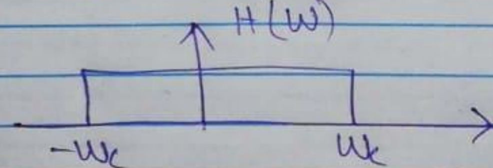


So these are the signals which involve in sampling.

$x(t)$, $\delta_s(t)$, $g(t)$.
↓ continous signal ↓ impulse signal ↓ Sample signal.

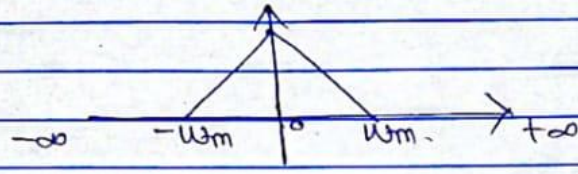
C,
When we pass a signal from LPF.

$S(t) \longrightarrow$ [LPF] $\longrightarrow m_r(t)$



So,
cutt off frequency :-

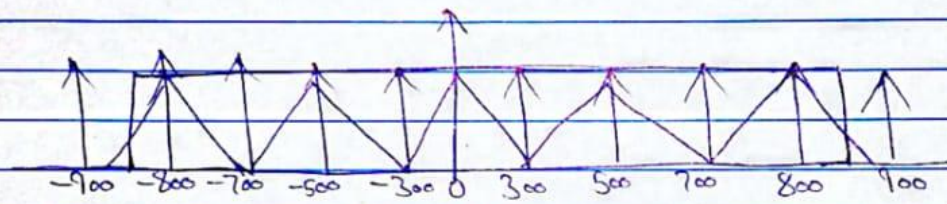
Date (4)

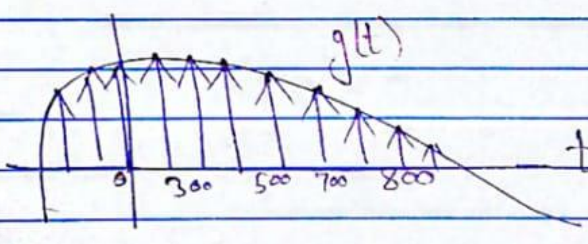


d, :-

if $f_s = 800$ Hz

Resulting sample signal.





Question 2 (10)

xt be a signal with Nyquist rate

sf

determine the Nyquist rate for following

i. ( ) (1) x t x t

Date (1)

QUESTIONS 2 :-

PART A :-

i) $x(t) + x(t-1)$

Solution:-

Given Nyquist rate $= f_s$

So,

$m(t) = x(t) + x(t-1)$

↓

This is our message signal.

$x(t)$ = Nyquist rate $= f_s$

So,

$x(t) = f_s$

When we do time shifting.

$x(t) \xrightarrow{T.S} x(t-1)$

We get $x(t-1)$ after time shifting.

Therefore,

Nyquist rate for $x(t-1) = f_s$

So,

$x(t) = f_s$
$x(t-1) = f_s$

Therefore

$m(t) = f_s$

Answer

ii. () dx t

Date (2)

(ii) $\frac{dx(t)}{dt}$

Now,

$$m(t) = \frac{dx(t)}{dt}$$

So if $x(t) = f_s$

Nyquist rate $x(t) = f_s$

So,

after derivation

$$\frac{dx(t)}{dt} = f_s$$

So the Nyquist rate of $\frac{dx(t)}{dt}$ is also f_s.

$$\boxed{\frac{dx(t)}{dt} = f_s}$$

Answer

dt b. Let ( ) 10sin400 m t 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 () yt

Date (3)

QUESTION 2 :-

(PART B)

Solution :-

Given :-

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

$f_s = 300\ Hz$

Cutt off frequency $= 150\ Hz$.

frequency or frequencies present in reconstructed signal ?

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

So,

$\omega_m = 400\pi$ rad/sec

Now,

$f_m = \frac{\omega_m}{2\pi}$

$= \frac{400\pi}{2\pi}$

$\boxed{f_m = 200\ Hz}$

$f_s = 300\ Hz$

$f_c = 150\ Hz$

$s(t) \longrightarrow$ [ideal LPF] $\longrightarrow m_r(t)$

Date (4)

$nf_s \pm f_m$

Now,

finding frequency component of reconstruct signal.

n = 0,

$n = 0 \Rightarrow \pm f_m = \pm 200\,Hz$

$n = 1 \Rightarrow \pm f_s \pm f_m = 500\,Hz, 100\,Hz$

$n = -1 \Rightarrow -f_s \pm f_m = -100\,Hz, -500\,Hz$

Frequency component of input is b/w $-150\,Hz$ to $+150\,Hz$

So

the reconstruted signal frequency component is b/w

$-100\,Hz$ to $100\,Hz$.

So,

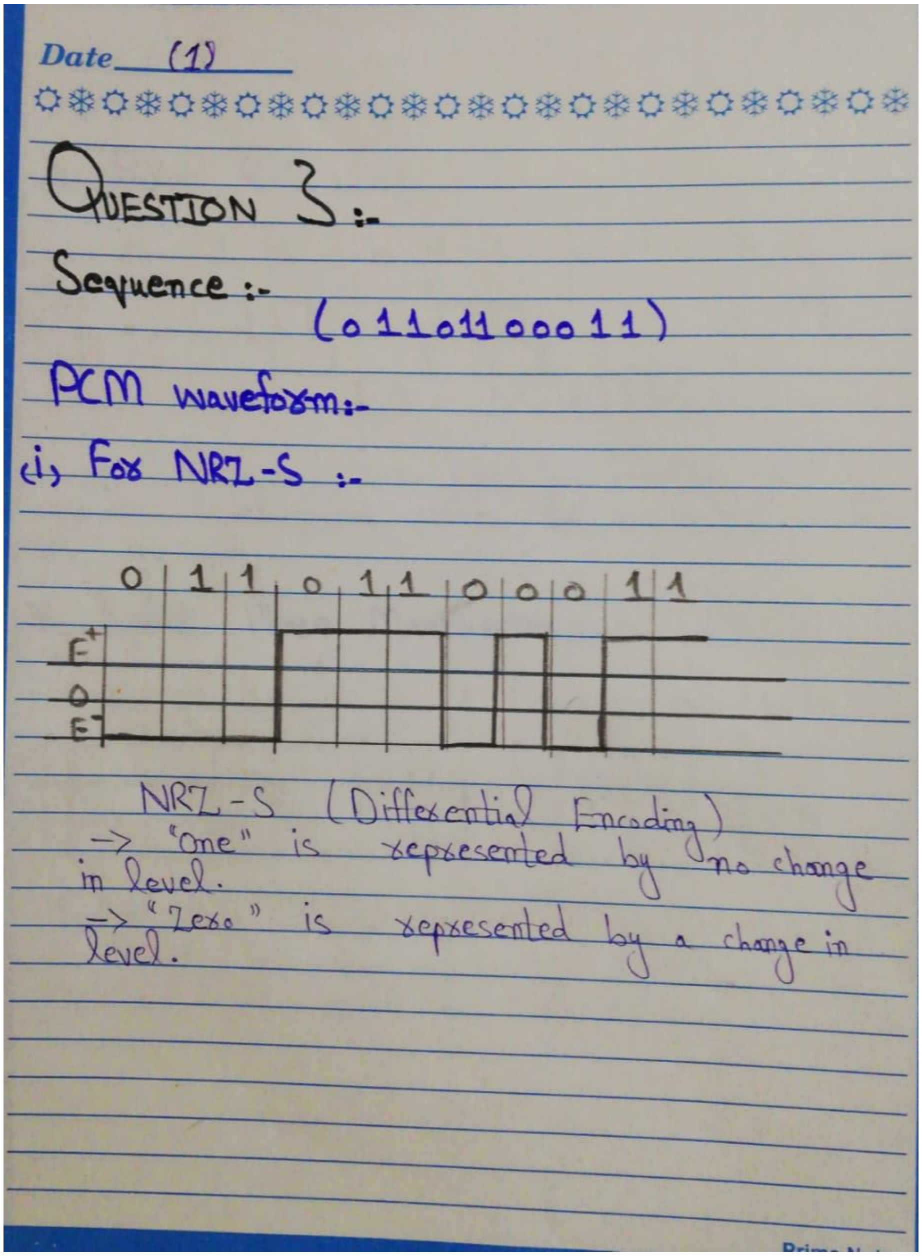
Frequency present in reconstructed signal is

$$\boxed{y(t) = 100\,Hz}$$

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



Date (1)

QUESTION 3 :-

Sequence :- (0 1 1 0 1 1 0 0 0 1 1)

PCM waveform:-

(i) For NRZ-S :-

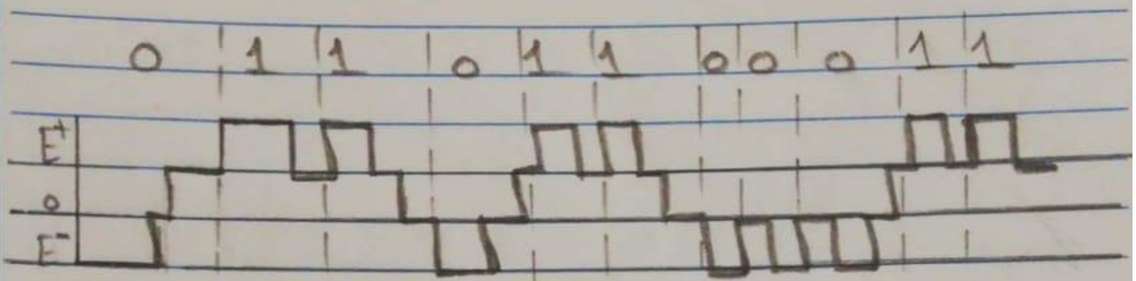
NRZ-S (Differential Encoding)

-> "One" is represented by no change in level.

-> "Zero" is represented by a change in level.

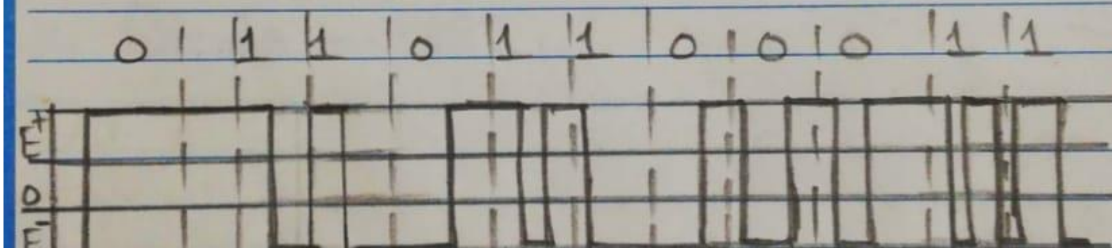
Date (2)

(ii) Polar R-Z :-



-> "One" and zero are representing by opposite level polar pulses that are one half-bit in width.

(iii) Split Phase Manchester :-



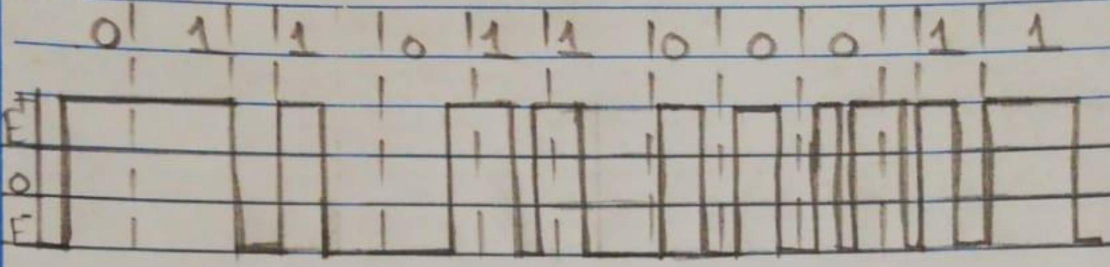
Split Phase Manchester :-

-> "One" is represented by 10.

-> "Zero" is represented by 01.

Date (3)

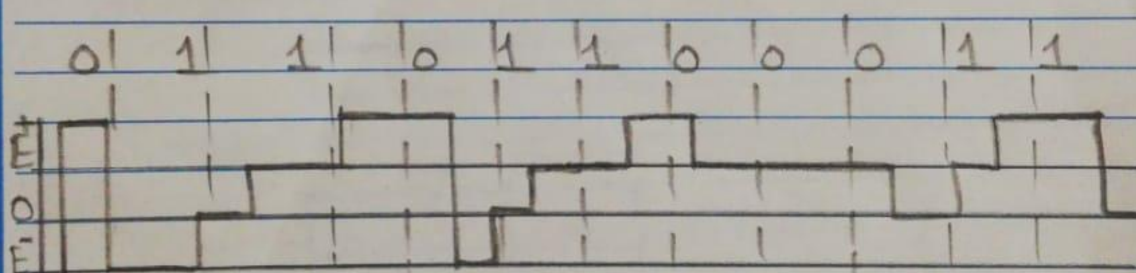
iv, Bi Φ L :-



Bi Φ L :-

-> "One" is represented by 10.
-> "Zero" is represented by 01.

v, Dicode - NRZ :-



\Question 4 (15)

a. A carrier wave is represented by the equation e_c (t) 7.5sin20x10^3 πt If the modulation index of wave is 0.5, draw the waveform of AM modulated waveform. b. A sinusoidal carrier 5 10cos50 10 t is amplitude modulated by the sinusoidal voltage of 35cos628 10 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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QUESTION 4 :- (PART A)

Solution :-

Given :-

$m = 0.5$ $e_c = 7.5$ $\therefore$ $E_c = 7.5$ volts

Let us evaluate E_m from E_c. Since $m = \frac{E_m}{E_c}$

Therefore,

$$E_m = m \times E_c$$
$$= 0.5 \times 7.5$$
$$\boxed{= 3.75 \text{ Volt}}$$

$$E_{max} = E_c + E_m$$
$$= 7.5 + 3.75$$
$$\boxed{= 11.25 \text{ volt}}$$

$$E_{min} = E_c - E_m$$
$$= 7.5 - 3.75$$
$$\boxed{= 3.75 \text{ volt}}$$

Modulated waveform :-

So,

As we know,

$m = 0.5$

$E_{max} = 11.25$

$E_{min} = 3.75$

Prime Notes

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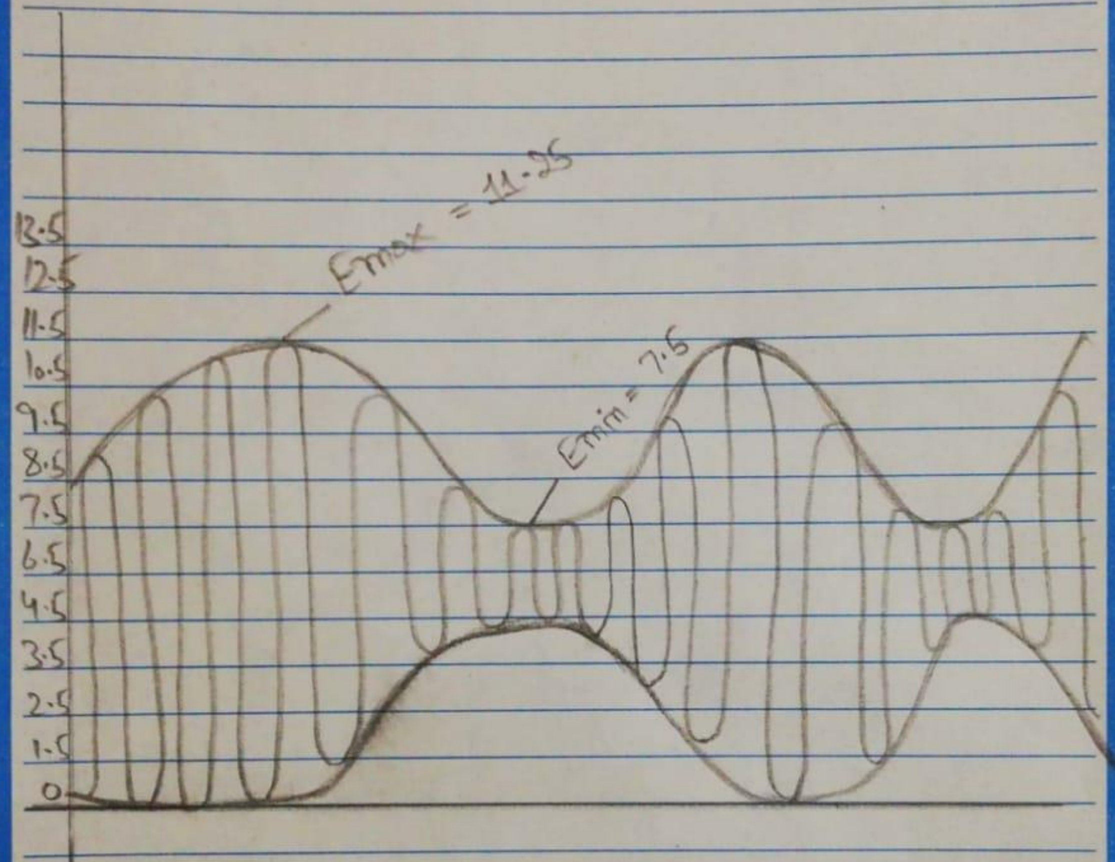

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PART B QUESTION 4 :-

Solution :-

Carrier Signal $= 10 \cos 50 \times 10^5 t$
Message " $= 5 \cos 628 \times 10^3 t$
$R = 50\ \Omega$

a, Depth :-

$$m = \frac{50 \times 10^5}{628 \times 10^3}$$
$$= 7.96$$

Power of both side.

$$P_{LSB} = P_{USB} = P_c \frac{u^2}{4}$$

$$P_C = \frac{A_c^2}{2R} = \frac{(10)^2}{2 \times 50}$$

$$P_C = 1W$$
$$= \frac{1 \times 7.96}{4}$$
$$P_{LSB} = P_{USB} = 1.99W$$

Efficiency of AM :-

$$\eta = \frac{P_{LSB} + P_{USB}}{P_t} = \frac{u^2}{2+u^2} = \frac{(7.96)^2}{2+7.96} = 6.1$$

Date

c, Total power :-

$$P_t = \frac{P_{cu}^2}{2}$$

$$= \frac{1 \times (7.96)^2}{2}$$

$$\boxed{= 31.68\ W}$$

d,

Power in USB %

Power in USB = 1.99 W

% power in USB = $\frac{1.99}{100}$ = $\boxed{0.0199\%}$