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Communication System

Q#1

Data $f_m = 250\ Hz$

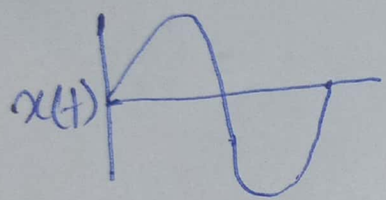
(a)

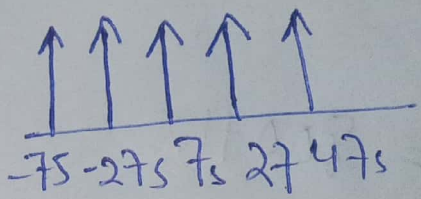
Nyquist Rate

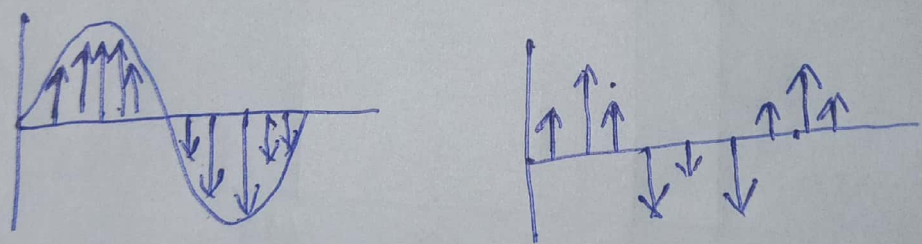
$NR = 2f_m$

$= 2 \times 250 = 500\ Hz$

(b)







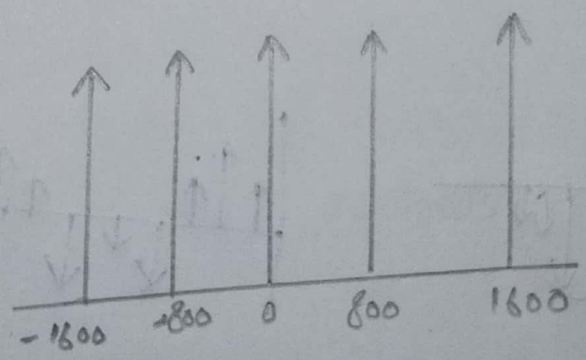
(2)

(c) Cutt off frequency

159.2 Hz

$$f_c = \frac{1}{2\pi \, RC} \Rightarrow \frac{1}{2\times 3.14\times 500} = 159.2\ Hz$$

(d) $f = 800$ Hz



Q#2

A

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

$x(t) \longrightarrow NR = ws$

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

$x(t) = ws$

$x(t-1) = ws$

It is same Because there is no effect of time shifting on Nyquist rate.

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

Those two signals have the same Nyquist rate (ws).

& to get the nyquist rate of m(t) we need to choose the nyquist rate which is maximum. But both the nyquist rate of $x(t)$ & $x(t-1)$ are same, so by properties of nyquist rate of

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

$$\downarrow \qquad \downarrow \qquad \downarrow$$

$$\omega_s \qquad \omega_s \qquad \omega_s$$

The two nyquist rate are same

So, directly the nyquist rate of $m(t)$ is ω_s. Answer

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

so this time the message signal is equal to 1 time derivative of signal $x(t)$. And we know the diffrenciation will not change the nyquist rate. so if the original signal is

$x(t) = \omega_s$

then $\frac{dx}{dt} = \omega_s$

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

so Answer is $\omega_s = \omega_s$

(6) (5)

Given:

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

$$\omega_m = 400\pi \ \frac{\text{rad}}{\text{sec}}$$

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

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

$$f_m = 200 \text{ Hz}$$

$$f_s = 300 \text{ Hz}$$

$$f_c = 150 \text{ Hz}$$

Required:

what are the frequency / frequencies present in the reconstructed signal $y(t)$

(6)

Sol:

$$s(t) \longrightarrow \boxed{\text{LPF}} \longrightarrow m_r(t)$$
(Ideal)

we know the frequency component present of fourier transform of the sampled impulse

$$S(\omega) = nf_s \pm f_m$$

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

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

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

It is given that cut-off frequency is $f_c = 150\ Hz$

This means the frequency component of the input which are between

-150 to $+150$

outside the range other frequencies doesnt allow.

All frequencies are checked & only -150 to +150 ranged frequencies are passed.

So, our answer is 100 Hz

Q#3

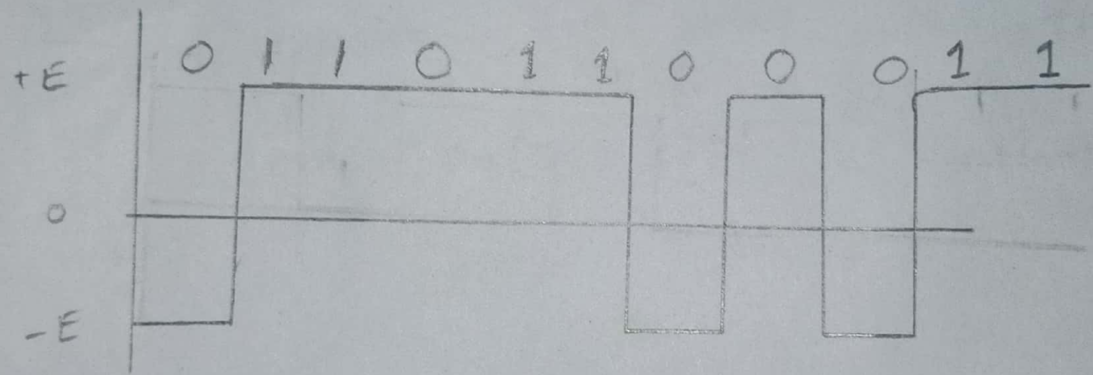
GIVEN:

Bit Sequence (0110110001)

Required:

Draw the wave forms (PCM) for the following modulations scheme.

1. NRZ-S

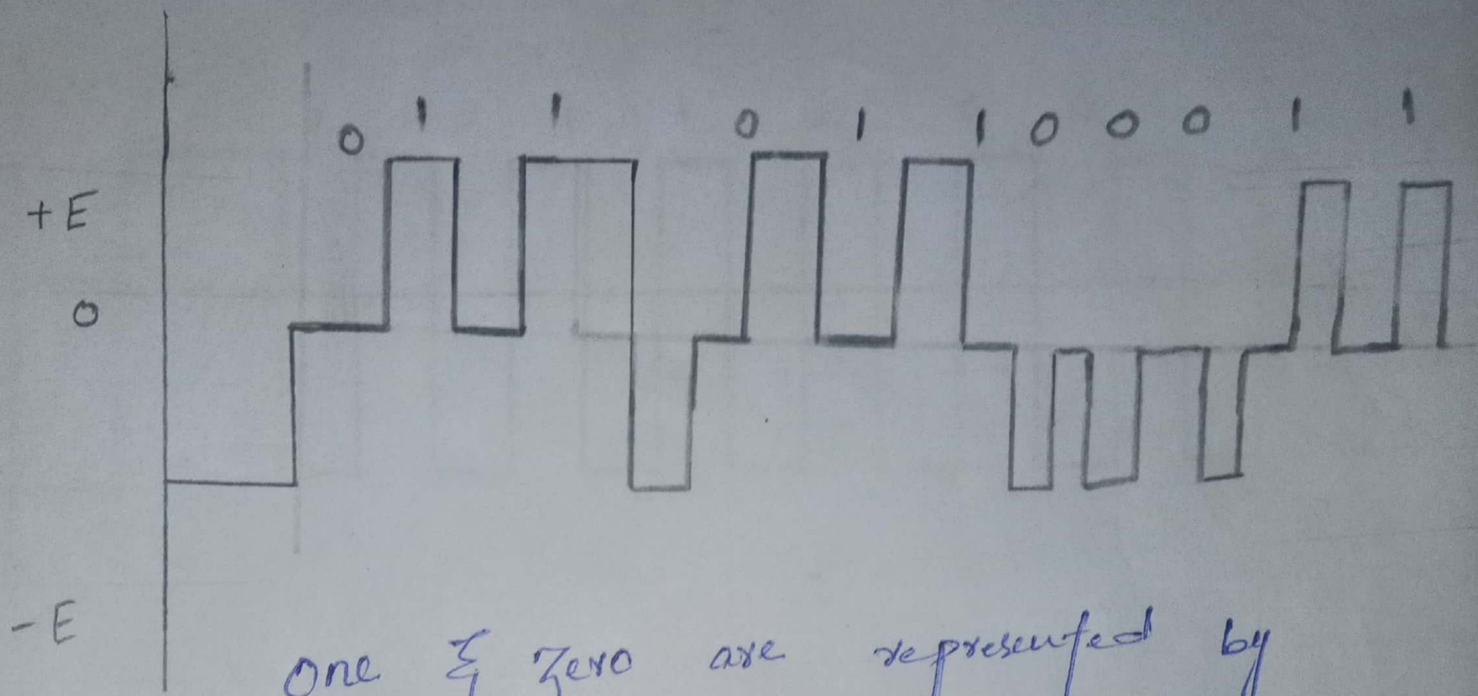


NRZ ~~Mark~~ Space

One is represented by a no change in level

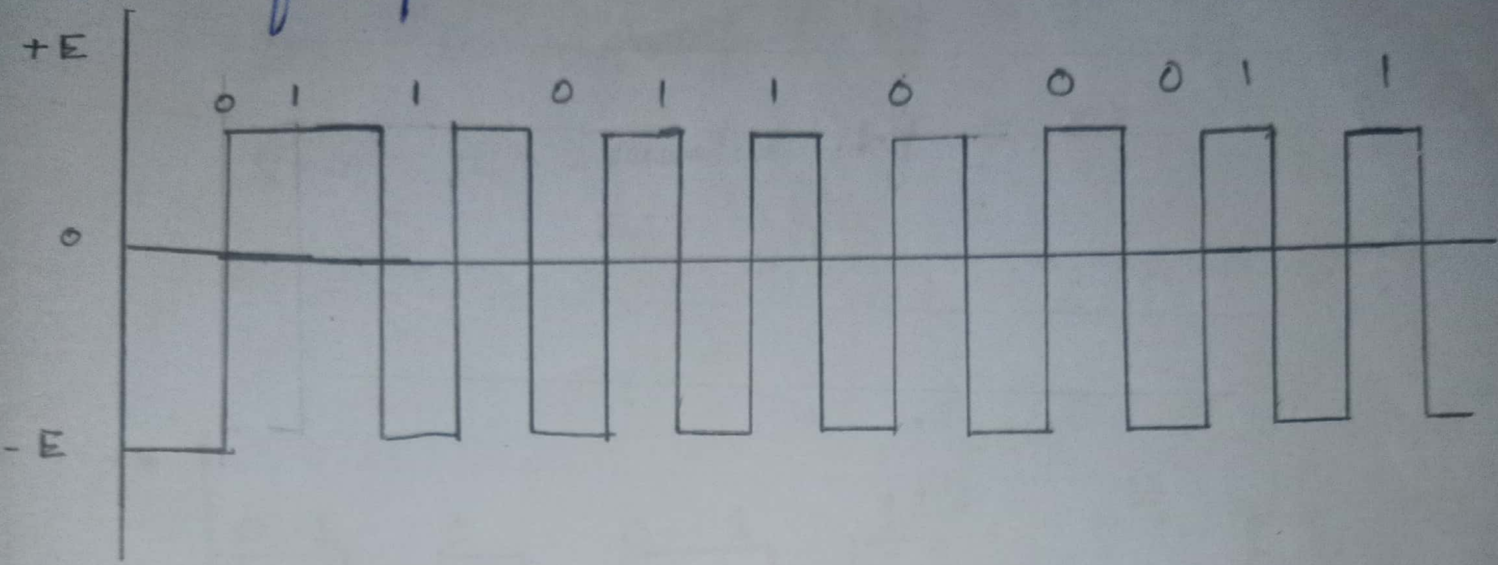
Zero is represented by change in level.

(2) Polar - RZ



One & zero are represented by opposite level polar pulses that are one half-bit in width

3) Split phase Manchester:



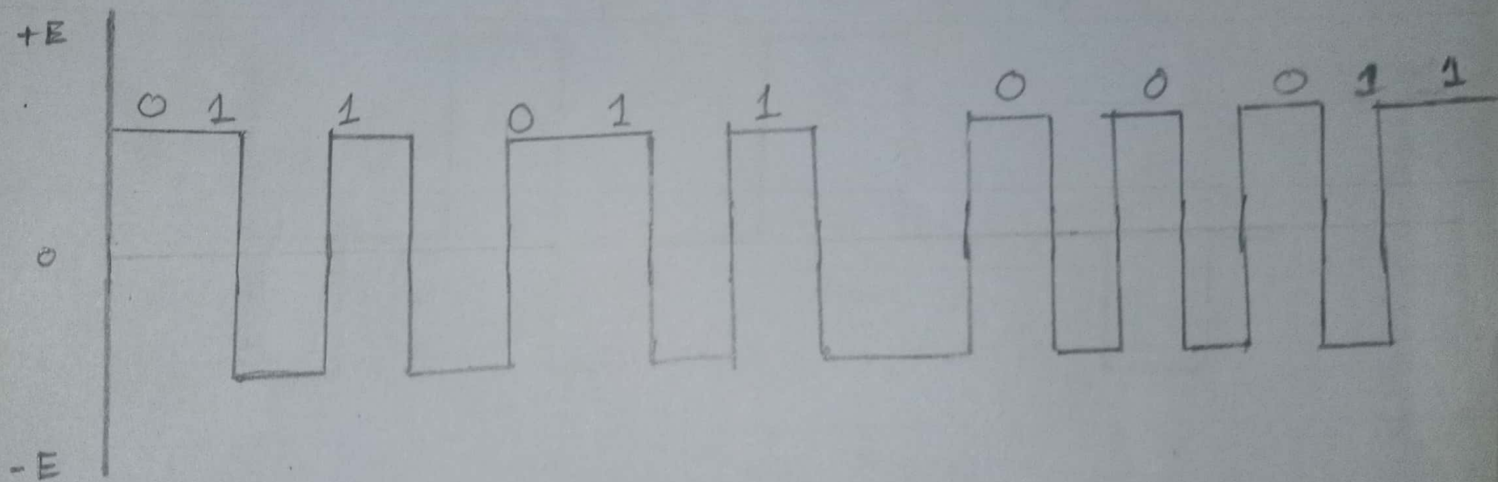
one is represented by a 10

Zero is represented by a 01

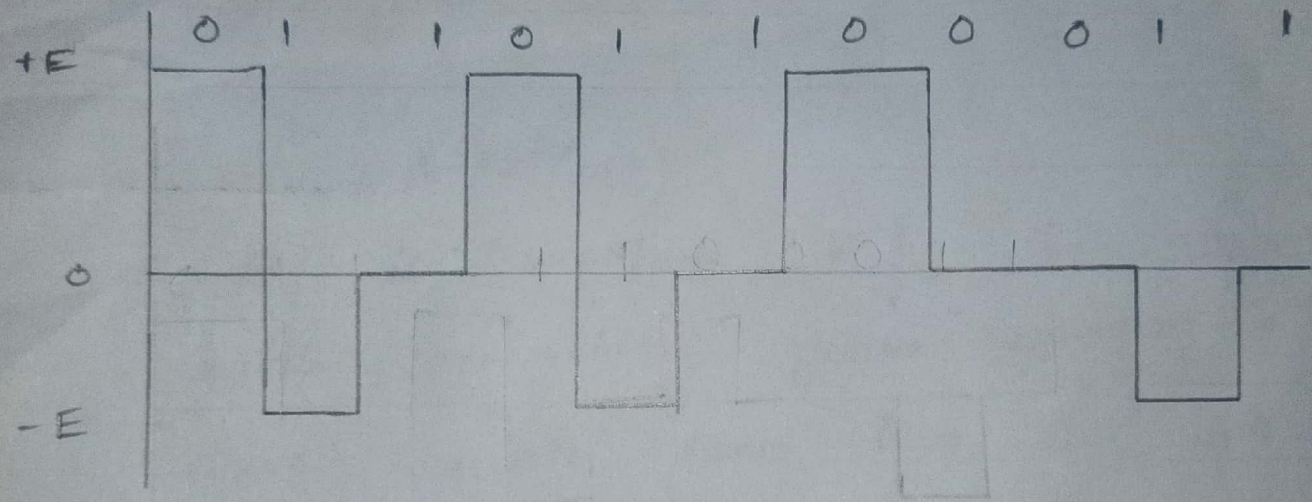
4) Bi-ϕ-L

one is represented by a 10

Zero is represented by a 01



⑤ Dicode - NRZ



Dicode Non return to Zero

A one to zero or zero to one changes polarity.

Otherwise, a zero is sent.

(13)

Q #4

A) Carrier wave is $e_c(t) = 7.5 \sin 20 \times 10^3 \pi t$

Modulation Index = $Mi = 0.5$

The general equation of sine wave is

$C = A \sin(\omega t)$

A is amplitude of the wave

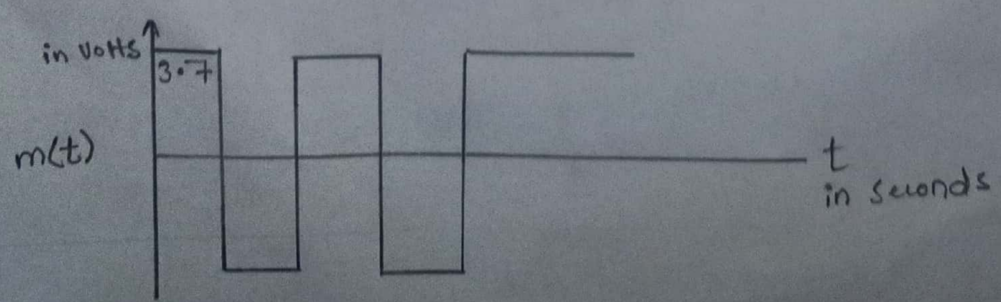
with comparing general equation of wave with given then AC will be 7.5

as we know that

$$m = MI = \frac{Am}{AC}$$

$Am = mi \times AC = 0.5 \times 7.5$

$Am = 3.75$



Q#4(B) (14)

(a) $m=0.5$ $E_c=7.5$ $E_c=7.5$ volts

let us considered Em from Ec
Sine

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

there fore

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

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

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

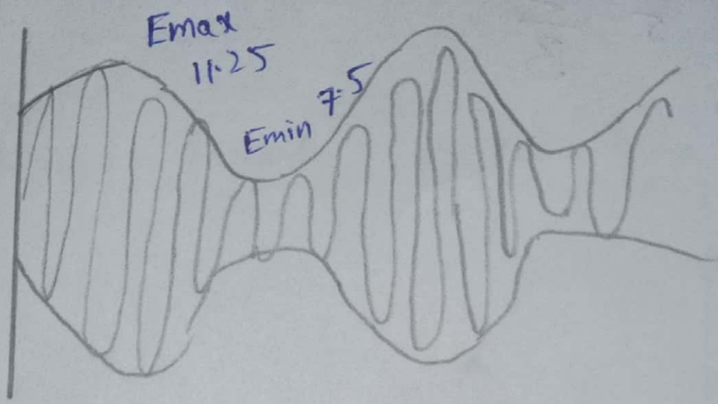
Modulated wave form

So as we know that

$n = 0.5$

$E_{max} = 11.25$

$E_{min} = 3.75$



(b) Depth of modulation

$$m = \frac{Em}{Ec}$$

$$m = \frac{10V}{5V} = 2V$$

transmmision effiency

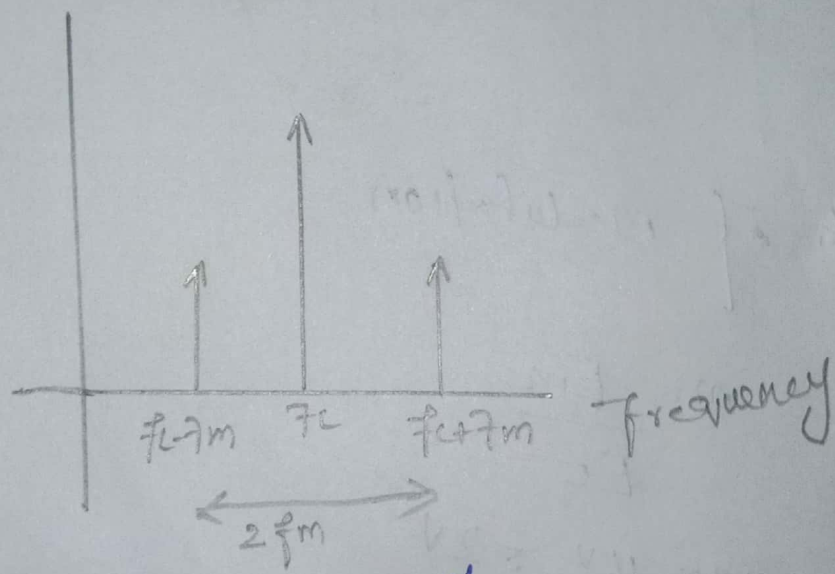
$$tf = \frac{m^2}{2+m^2}$$

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

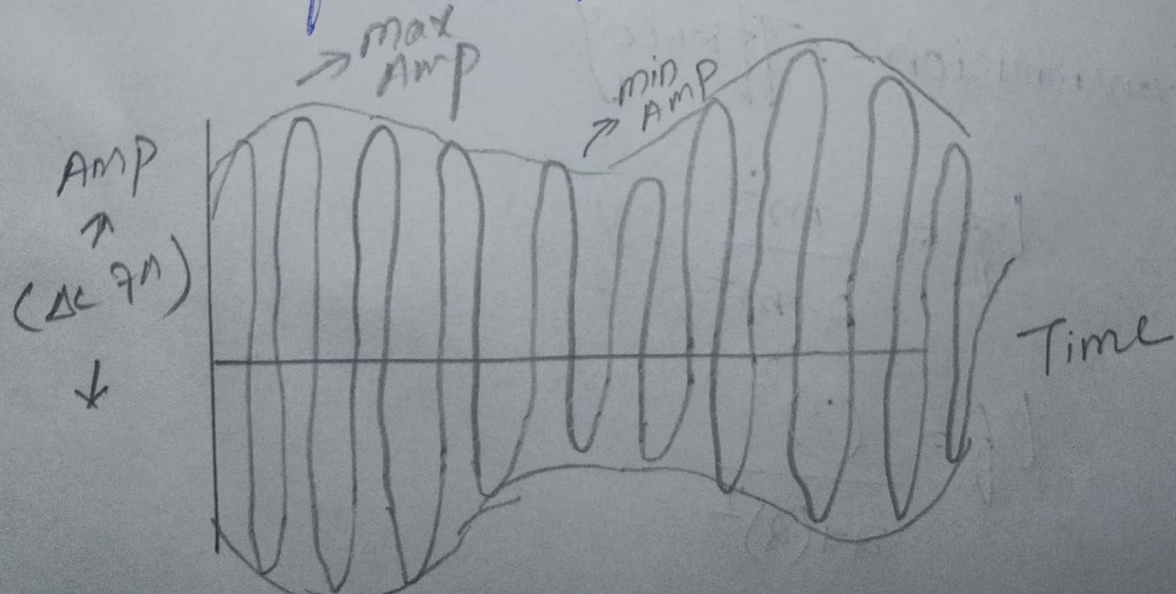
$$\eta = \frac{4}{2+4}$$

$$= \frac{4}{6}$$

$$= \frac{2}{3}$$



Amplitude - frequency



(c)

power in spectrum:

$$P_c = \frac{E_c^2}{2 \times R} = \frac{(5)^2}{2 \times 50} = \frac{25}{100} = 1/4$$

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

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

$$= \left[\frac{1+4}{2}\right] \times 0.2$$

$$= (1+2) \times 0.2$$

$$= 3 \times 0.2$$

$$\boxed{P_t = 0.6}$$

d) percentage power in USB

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

$$= \frac{m^2}{4} P_C$$

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

$$\boxed{P_{USB} = 0.6\%}$$