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PAPER:	**COMMUNICATION SYSTEM**
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EXAM:	**MID TERM**

Department of Electrical Engineering

Mid Assignment Summer 2020

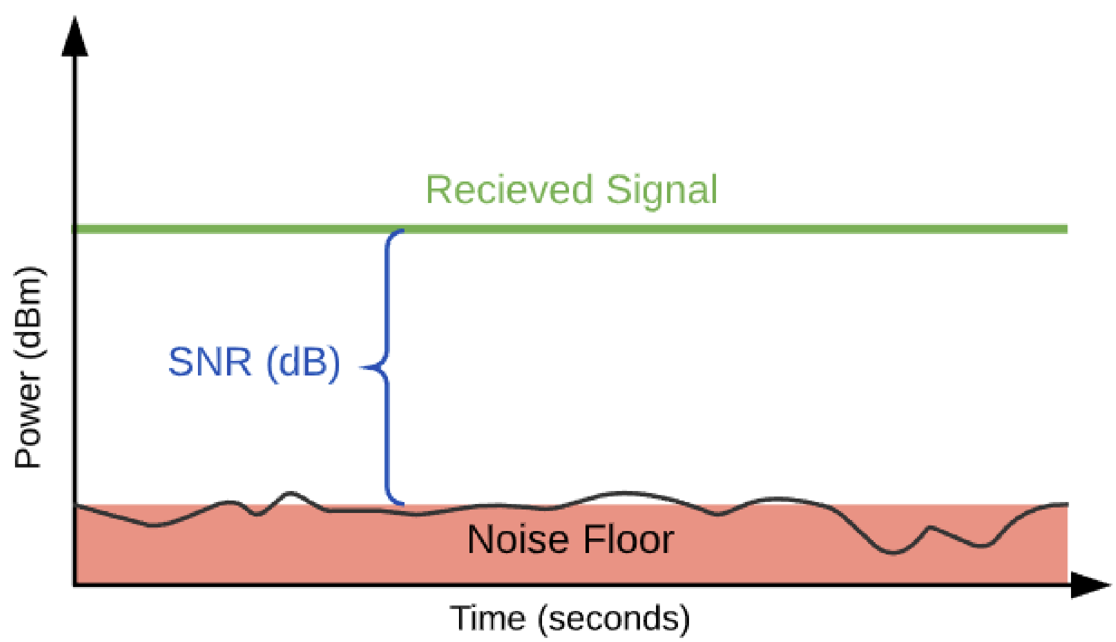
Subject: Communication Systems

Question 1:

a. How SNR is related to quality of received signal in a wireless communication system?

ANSWER:

The SNR is the difference between the received wireless signal and the noise floor. ... For example, if a client device's radio receives a signal at -75 dBm, and the noise floor is -90 dBm, then the effective SNR is 15 dB. This would then reflect as a signal strength of 15 dB for this wireless connection. The SNR is the difference between the received wireless signal and the noise floor. The noise floor is simply erroneous background transmissions that are emitted from either other devices that are too far away for the signal to be intelligible, or by devices that are inadvertently creating interference on the same frequency.



The further a received signal is from the noise floor, the better the signal quality. Signals close to the noise floor can be subject to data corruption, which will result in retransmissions between the transmitter and receiver. This will degrade wireless throughput and latency as the retransmitted signals will take up airtime in the wireless environment. Cisco Meraki Access Points reference the Signal to Noise Ratio as the indication for the quality of the wireless connection. This provides a more accurate depiction of the health of the wireless signals as it takes the RF environment and ambient noise levels into account. For instance, a received signal of -65 dBm can be considered good at a location that has a noise floor of -90 dBm (SNR 25 dB) but not so much at a location with a noise floor of -80 dBm (SNR 15 dB).

Generally, a signal with an SNR value of 20 dB or more is recommended for data networks where as an SNR value of 25 dB or more is recommended for networks that use voice applications.

SNR AND QUALITY OF RECEIVED SIGNAL:

The further a received signal is from the noise floor, the better the signal quality. ... Generally, a signal with an SNR value of 20 dB or more is recommended for data networks where as an SNR value of 25 dB or more is recommended for networks that use voice applications. Learn more about Signal-to-Noise Ratio.

EFFECT ON RECEIVED SIGNAL QUALITY:

When the SNR increases, the channel's data throughput also increases. This means that for a given signal level, an increase in noise will decrease the data throughput. The higher the noise level, the less space there is for the actual data that is being transmitted on the channel.

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b. Draw and explain the basic block diagram of a communication system?

ANSWER:

The elements of basic communication system are as follows

- **Information or input signal**
- **Input Transducer**
- **Transmitter**
- **Communication channel or medium**
- **Noise**
- **Receiver**
- **Output Transducer**

BLOCK DIAGRAM OF COMMUNICATION SYSTEM:

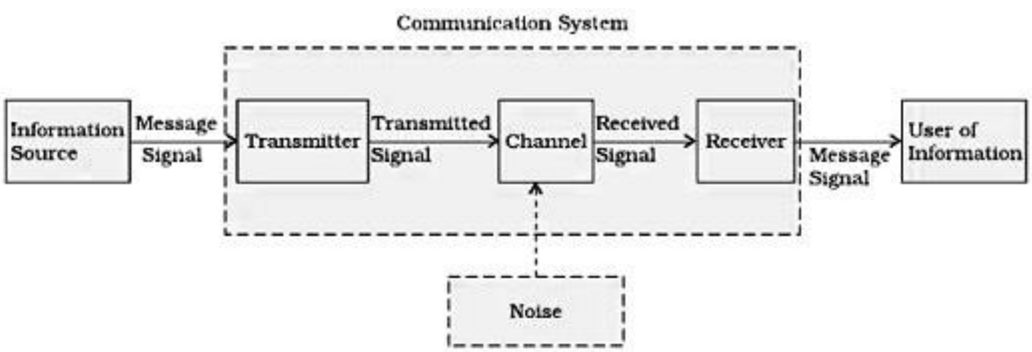

FIGURE 15.1 Block diagram of a generalised communication system.

1. Information or input signal

- **The communication systems have been developed for communicating useful information from one place to other**
- **The information can be in the form of sound signal like speech or music or it can be in the form of pictures.**

2. Input Transducer

- **The information in the form of sound, picture or data signals cannot the transmitted as it is.**
- **First it has to be converted into a suitable electrical signal.**
- **The input transducers commonly used in the communication systems are microphones, TV etc.**

3. Transmitter

- **The function of the transmitter block is to convert the electrical equivalent of the information to a suitable form**
- **It increases the power level of the signal. The power level should be increased in order to cover a large range. The transmitter consists of the electronics circuits such as amplifier, mixer, oscillator, and power amplifier.**

4. Communication channel or medium

- **The communication channel is the medium used for the transmission of electronic signals from one place to the another.**
- **The communication medium can be conducting wires, cables, optical fibres or free space. Depending upon the type of the communication medium, two types of the communication system will exist**

  a. Wire communication or line communication

  b. Wireless communication or radio communication

5. Noise

- **Noise is an unwanted electrical signal which gets added to the transmitted signal when it is travelling towards receiver.**
- **Due to noise, the quality of the transmitted information will degrade. One added the noise cannot be separated out from the information**

- **Hence noise is ab big problem in the communication systems.**

6. Receiver

- **The reception is exactly the opposite process of transmission. The received signal is amplified and demodulated and converted in a suitable form**
- **The receiver consists of the electronic circuits like mixer, oscillator, detector and amplifier.**

7. Output Transducer

- **It consists of the electrical signal at the output of the receiver back to the original form i.e. sound or TV pictures.**
- **The typical example of the output transducers are loud speakers, picture tubes etc.**

…………………………………………………………………………………...

c. Why is it required to modulate the signal for distant wireless communication?

ANSWER:

The baseband signals are incompatible for direct transmission. For such a signal, to travel longer distances, its strength has to be increased by modulating with a high frequency carrier wave, which doesn't affect the parameters of the modulating signal.

WHY MODULATION IS REQURIED:

Modulation allows us to send a signal over a bandpass frequency range. If every signal gets its own frequency range, then we can transmit

multiple signals simultaneously over a single channel, all using different frequency ranges. To answer this question, let's consider a channel that essentially acts like a bandpass filter: both the lowest frequency components and the highest frequency components are attenuated or unusable in some way, with transmission only being practical over some intermediate frequency range. If we can't send low-frequency signals, then we need to shift our signal up the frequency ladder. Modulation allows us to send a signal over a bandpass frequency range. If every signal gets its own frequency range, then we can transmit multiple signals *simultaneously* over a single channel, all using different frequency ranges.

Another reason to modulate a signal is to allow the use of a smaller antenna. A baseband (low frequency) signal would need a huge antenna because in order to be efficient, the antenna needs to be about 1/10th the length of the wavelength. Modulation shifts the baseband signal up to a much higher frequency, which has much smaller wavelengths and allows the use of a much smaller antenna.

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d: Digital signals are not preferred for the communication over wireless communication channel despite the fact they are easy to represent and analyze. please support the statement with your argument.

ANSWER:

In analog systems, signals of varying frequency or amplitude are used to modulate the carrier waves. Analog signals are continuously changing (infinite values) and are represented as a series of sine waves. The AM and FM radio transmissions are the most common examples of analog transmission.

The reason for this is “baseband” digital signals don’t propagate well or efficiently because their effective “radio frequency” can range from ~0 Hz to 10x the clock frequencies used, and radio waves have radically different propagation method and efficacies in that range. Hence, we use something called “modulation” to put the signal at one narrow range of frequencies that have known and controllable propagation features.

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e. Determine the power and rms value of ft= C cos(ω0t+Ө)?

ANSWER:

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PART D of QUESTION 1 :-

$f(t) = C \cos(w_0 t + \theta)$

This is periodic signal with period $T_0 = 2\pi / w_0$. The suitable measure of size is power. In periodic signal we compute its power by averaging its energy over one periodic signal over one period. $2\pi/w_0$.

$$P_g = \lim_{T\to\infty} \frac{1}{T} \int_{-T/2}^{T/2} C^2 \cos^2(w_0 t + \theta)\, dt =$$

$$\lim_{T\to\infty} \frac{1}{T} \int_{-T/2}^{T/2} \frac{C^2}{2} [1 + \cos(2w_0 t + 2\theta)]\, dt$$

$$= \lim_{T\to\infty} \frac{C^2}{2T} \int_{-T/2}^{T/2} C^2 \cos(2w_0 t + 2\theta)]\, dt$$

$$= \lim_{T\to\infty} \frac{C^2}{2T} \int_{-T/2}^{T/2} dt + \lim_{T\to\infty} \frac{C^2}{2T} \int_{-T/2}^{T/2} \cos(2w_0 t + 2\theta$$

The first term on the right hand side equals $C^2/2$. While second term is zero, because the integral appearing in this term represents the area under a sinusoid over a very large time interval T with $T \to \infty$. This area is at most equal to the area

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of half the cycle because of cancellation of the positive and negative area of Sinusoid.

QUES 2

Two sinusoidal signals 6 5cos2 10 t □
and 3 3cos2 10 t □
are desired to be transmitted over the distance of 20 kilometers. Determine the height of antennas for each signal required to receive the transmitted signals efficiently

Date:

QUESTION 2 :-

PART 1 :-

a, $5 \cos 2\pi 10^6$

$$h = \frac{\lambda}{4}$$

$$= \frac{c}{4f}$$

$f = 10^6$ $S = 20$ km

putting the values

$$h = \frac{c}{4f}$$

$$h = \frac{3 \times 10^{8^2}}{4 \times 10^6}$$

$$\boxed{h = 75 \text{ meter}}$$

b, $3 \cos 2\pi 10^3 t$

$$h = \frac{c}{4f}$$

$f = 10^3$ $\Rightarrow$ $h = \frac{c}{4f}$

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$$h = \frac{3 \times 10^{\not 8\, 5}}{4 \times 10^{\not 3}}$$

$$h = \frac{3 \times 10^5}{4}$$

h = 75,000 meters.

MASTER NOTES

Derive the expression for effective power accumulated in the spectrum of an AM wave

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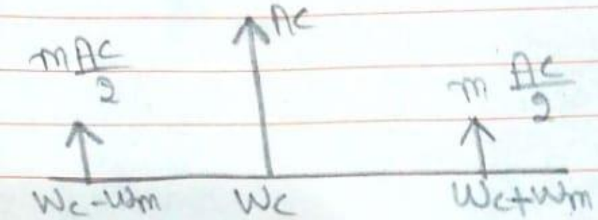
QUESTION 2 PART B :-

Power of AM wave :-



$\Rightarrow X_{Am}(t) = A_c \cos w_c t = m\frac{A_C}{2}\left[\cos(w_c - w_m)\right.$
$\left. + \cos(w_c + w_m)\right]$

$\Rightarrow X_m(t) = \pi A(\delta(w - w_c) + \delta(w + w_c) + \frac{1}{2}\left[X(w_c - w_m)\right.$
$\left. + X(w_c - w_m)\right]$

Power = Power (Lower side band) + Power (upper S.B)
$+ P_C$

A_C / V_C

V_C, rms $= V_c / \sqrt{2}$

V_m, rms $= V_m / \sqrt{2}$

$P_C = \frac{V_C^2}{R} \Rightarrow \frac{V_C^2}{\sqrt{2} R} \Rightarrow \frac{V_C^2}{2R}$

$P_m = \frac{V_m^2}{R} \Rightarrow \frac{V_m^2}{2R} \Rightarrow \left(\frac{mV_c}{2}\right)^2 / 2R$

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$$\frac{m^2 V_c^2}{4 \cdot 2R} \Rightarrow m^2 \cdot P_C$$

$$P_t = P_C \left(1 + \frac{m^2}{2}\right)$$

$$\text{Bandwidth} = f_H - f_L$$

$$B = (\omega_c + \omega_m) - (\omega_c - \omega_m)$$

$$\boxed{B = 2\omega_m}$$

QUES 3 PART (a)

Draw and explain the AM waveform for less than 100%, 100% and greater than 100% modulation cases considering carrier signal ( ) 12sin

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QUESTION 3 :-

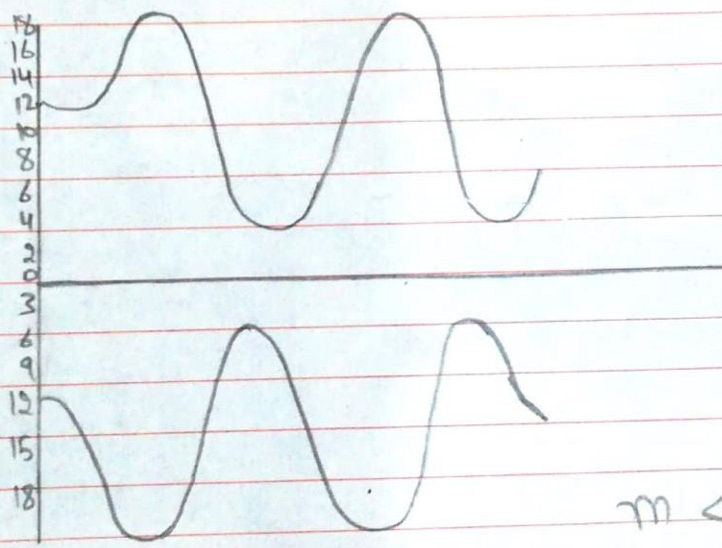
PART A :-

(i) $A_m = 6$

$A_c = 12$

$(A_C > A_m)$

$m < 100\%$



$m < 100\%$

(ii) $A_m = 12$

$A_C = 12$

$A_C = A_m$

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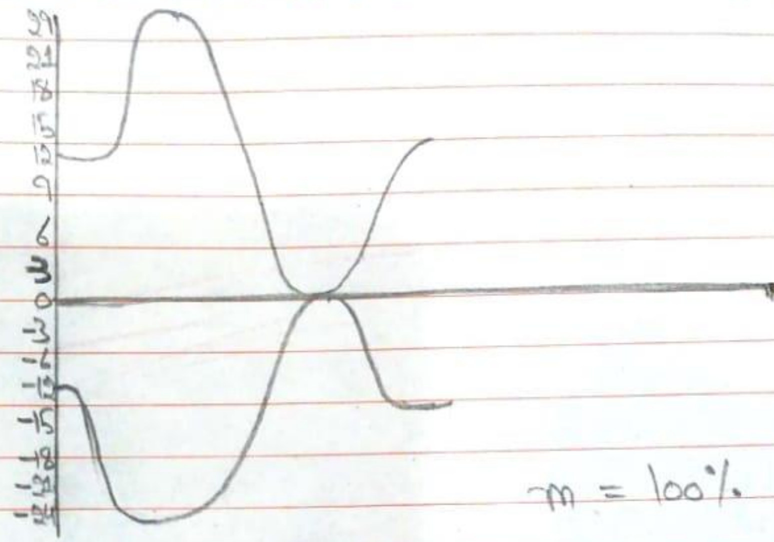
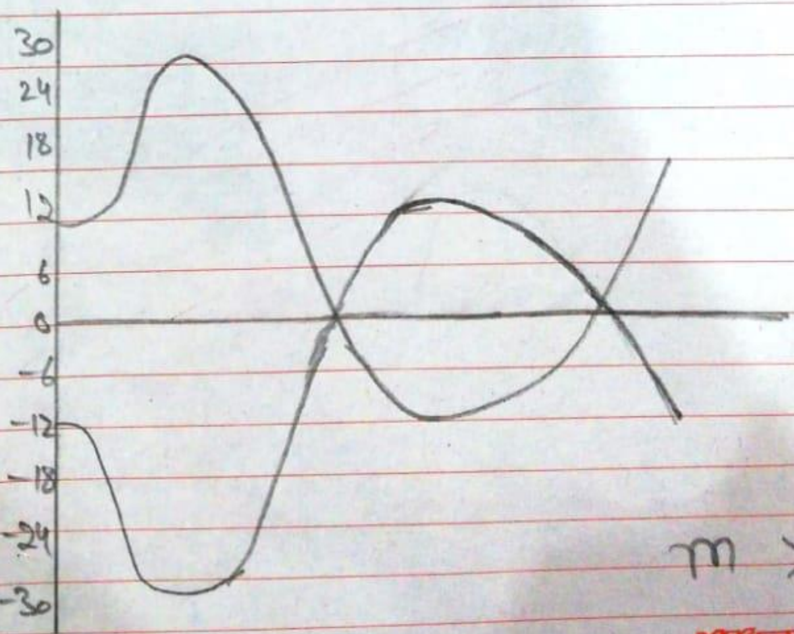


$m = 100\%$

(iii)

$A_m = 18$
$A_C = 12$
$(A_C < A_m)$



$m > 100\%$

MASTER NOTES

A sinusoidal carrier has amplitude of 7 V and frequency of 1 MHz It is amplitude modulated by the sinusoidal voltage of 3.5V and frequency 5 kHz.

i. Write the equation for message, carrier and modulated waves

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QUESTION 3:-

PART B:-

① Equations:-

Message Signal :-

$$m(t) = A_m \cos(2\pi f_m t)$$

Carrier :-

$$c(t) = A_c \cos(2\pi f_c t)$$

Modulation Equation :-

$$s(t) = A_c[1 + K_a m(t)] \cos(2\pi f_c t)$$

Now,

Carrier amplitude = 1MHz
Carrier voltage = 7V
Message Amplitude = 5KHz
Message Voltage = 3.5 V

$$m(t) = A_m \cos(2\pi f_m t)$$

$$= 3.5 \cos(2\pi 5KHz (t))$$

$$c(t) = A_c \cos(2\pi f_c t)$$

MASTER NOTES

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$$\boxed{= 7\cos(2\pi\, 1\,\text{MHz}\, t)}$$

$$S(t) = 7\left[1 + 3.5\cos(2\pi\, 5\,\text{KHz}\,(t))\right]\cos$$

$$(2\pi\, 1\,\text{MHz}\, t).$$

Prime Notes

ii. Plot the AM wave in time domain as well as its frequency domain spectrum

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(ii) Plot the AM wave :-

$\Rightarrow \quad x_m = 3.5 \cos (2\pi\, 5KH_z\, (t))$

$x_m(t) = 3.5 \cos 2\pi 5 \times 10^{2} t$

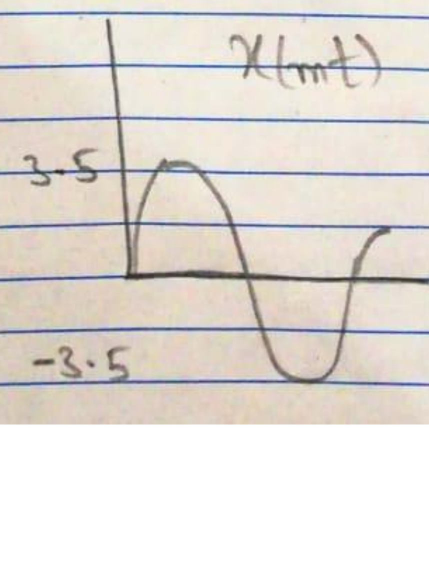
$\Rightarrow \quad x_c(t) = 7 \cos 2\pi\, 1 \times 10^{6} t$

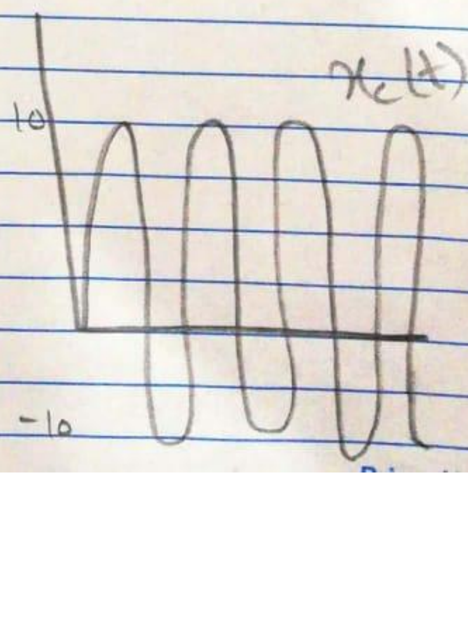
$$x_{Am}(t) = A_C \left[1 + \frac{A_m}{A_C} \cos 2\pi f_m t \right] \cos 2\pi f_c t$$

$$= 7 \left[1 + \frac{3.5}{7} \cos 2\pi 10^{2} t \right] \cos 2\pi \times 30 \times 10^{6} t.$$

$$X_{Am} = 7 \left[1 + 0.5 \cos 2\pi \times 10^{2} t \right] \cos 60 \times 10^{6} \pi t$$

Plot:-





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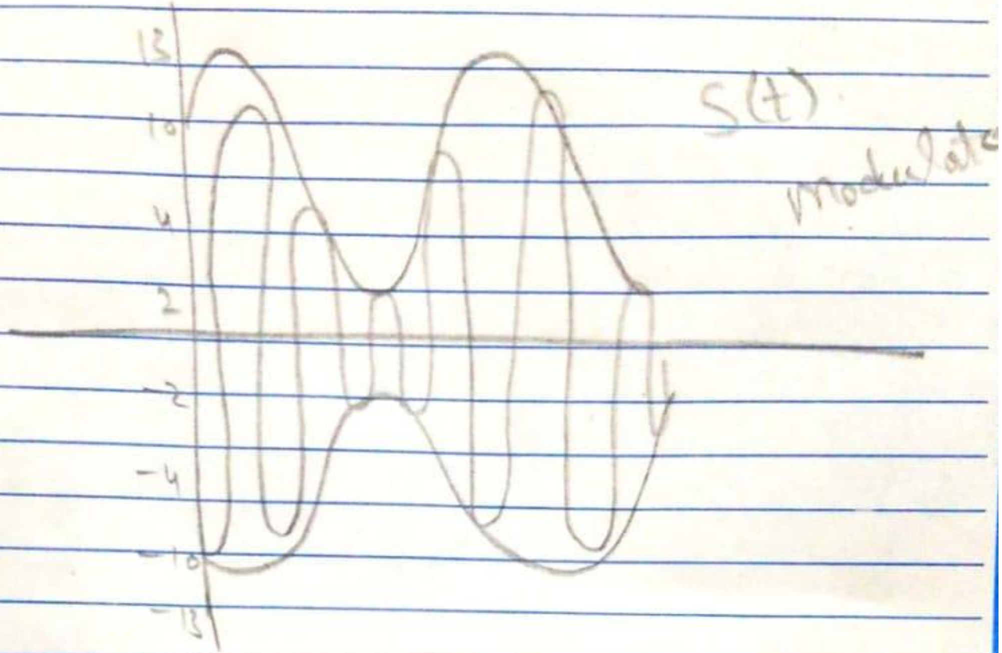
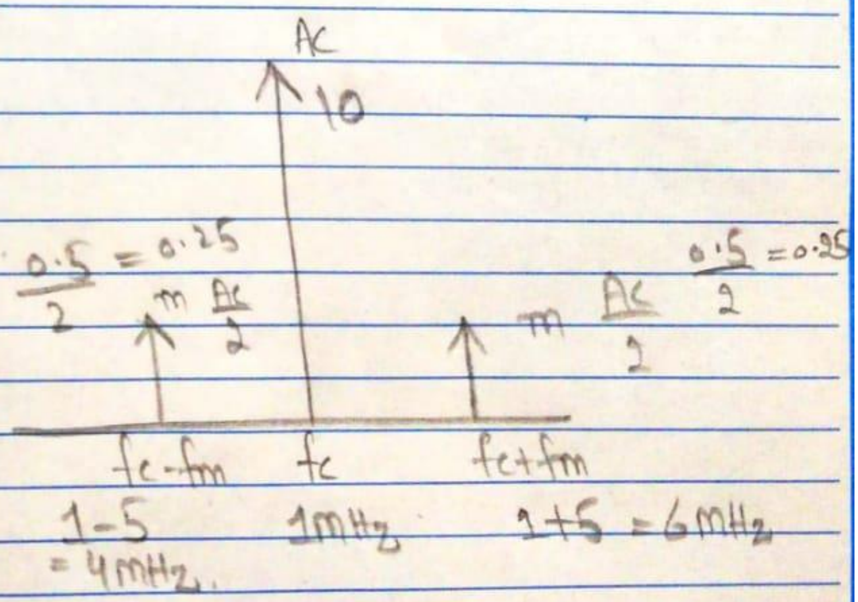


Spectrum :-



iii. Find the depth of modulation and calculate the transmission efficiency
iv. Calculate the total power in spectrum v. Calculate the percentage power in USB

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(1) Total power of Spectrum:-

$$Pt = Pc + P_{LSB} + P_{USB}$$

$$Pc + \frac{m^2 Pc}{4} + \frac{m^2 Pc}{4}$$

$$Pc = \frac{1 + m^2}{2}$$

$$= \frac{1 + 3.5}{2}$$

$$= \frac{4.5}{2}$$

$$\boxed{P = 2.25}$$

Prime Notes