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Section - EC-4

Unit-5
Assignment-5

Q1 Explains the elements of communication system with the help of block diagram.

Ans Communication is the transfer of information from point A to point B using electricity or magnetism.

- Communication can be divided into three parts

i) Transmitter (ii) Channel (iii) Receiver

(i) **Transmitter** → The transmitter section consist of

(A) **Information source** → It is used to generate message signal in the form of audio, video or data

(B) **Transducer** → It is a device which convert one form of energy. It converts raw message signal to electrical signal

(C) **Modulator** → Here low frequency message signal is superimposed on high frequency carrier signal so that can cover long distance

(D) **Amplifier** → It block is used to enhance the strength of signal before transmission

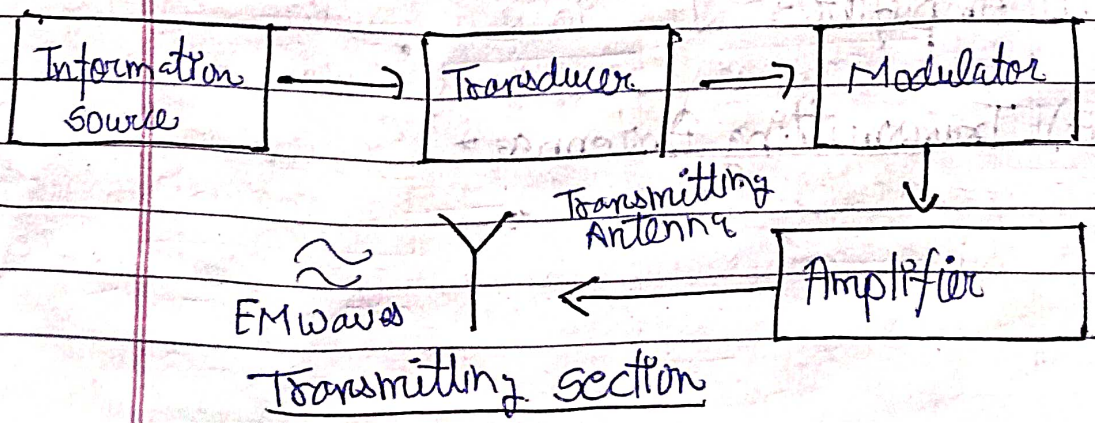
(E) **Transmitting Antenna** → It convert electrical signal into electromagnetic wave which can travel in the atmosphere

(ii) **Channels** → EM waves radiated from transmitting antenna travel through a path.

(A) **Wired channels** → When medium is physical
(B) **Wireless channels** → When medium is air

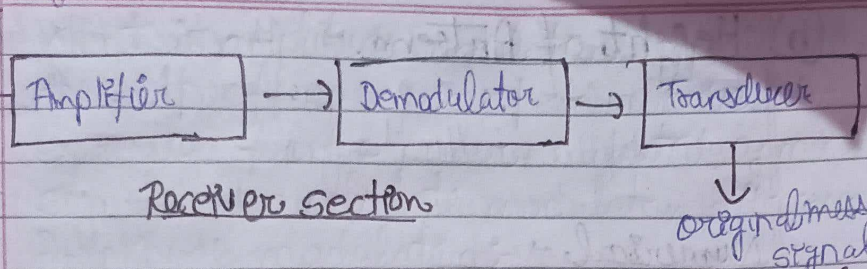
(ii) **Noise** → It is unwanted signal will mix with the transmitted signal
(a) **natural noise** → Source of natural noise radiation from sun & stars
(b) **man made noise** → Source of man made noise are automobiles, motors, etc.

(iii) **Receiver** → This section consist of
(A) **Receiving antena** → It converts recieved on waves from the channel into electrical signal
(B) **Amplifier** → Signal received at the receiver has suffered various types of losses.
(C) **Demodulator** → Used to seperate carrier from the message signal
(D) **Transducer** → It convert received message signal in the electrical from original form.



Transmitting section

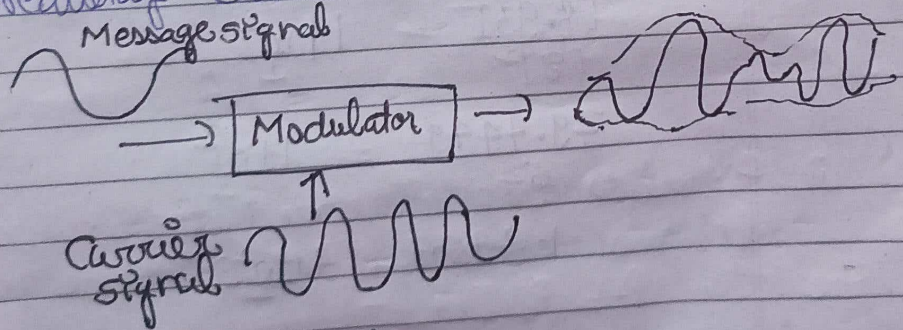
Receiving antenna



Q2 Define modulation. Why do we need modulation? The antenna current of an AM transmitter is 8A. When only the carrier is sent, but it increase to 8.93A. When the carrier is modulated by a single sine wave. Find percentage modulation. Determine the antenna current when it percent of modulation changes to 0.8.

Ans Modulation →

It is a process in which low freauency message signals is superimposed on the high freauency carrier wave.



Need of Modulation

(a) Interference or mixing problem →

As a message signal are generally low freaue signals there is large probability of mixing with other signals of the same freauency range also present in the atmosphere

Q3(b)

(b) Height of Antenna → Practical height of transmitting $= \frac{\lambda}{4}$, where λ is the wavelength of the signal.

Ans

Numerical →

$$I_t = I_c \sqrt{1 + \frac{m^2}{2}} \quad \text{— (1)}$$

$I_t = 8.93\ A$

$I_c = 8\ A$

put the value of I_t & I_c in eq (1)

$$\frac{I_t}{I_c} = \sqrt{1 + \frac{m^2}{2}}$$

Square both sides

$$\left[\frac{I_t}{I_c}\right]^2 = \left[\sqrt{1 + \frac{m^2}{2}}\right]^2$$

$$\frac{I_t^2}{I_c^2} = 1 + \frac{m^2}{2}$$

$$\frac{[8.93]^2}{[8]^2} = 1 + \frac{m^2}{2}$$

$$\frac{79.7449}{64} = 1 + \frac{m^2}{2}$$

$$1.2460 = 1 + \frac{m^2}{2}$$

$$\frac{m^2}{2} = 0.2460$$

$$m^2 = 0.4920$$

$$\boxed{m = 0.7014}$$

% modulation $= m \times 100 = 0.7014 \times 100$

$$\boxed{\%\ m = 70.14}$$

Q3(i) What is amplitude modulation. Explain with the help of proper waveform. Derive the expression for the power radiated by modulated signal. Also calculate modulation efficiency

Ans Amplitude modulation :-

In amplitude modulation, the amplitude of carrier signal is modulated according to the instantaneous amplitude of the message signal Frequency and phase of carrier remains constant

$$m(t) = A_m \sin \omega_m t$$

$$c(t) = A_c \sin \omega_c t$$

$$x_{AM}(t) = [A_c + m(t)] \sin \omega_c t$$

$$x_{AM}(t) = [A_c + m(t)] \sin \omega_c t$$

$$= (A_c + A_m \sin \omega_m t] \sin \omega_c t$$

$$= A_c \left[1 + \frac{A_m}{A_c} \sin \omega_m t\right] \sin \omega_c t$$

$$\frac{A_m}{A_c} = m$$

$$= A_c [1 + m \sin \omega_m t] \sin \omega_c t$$

$$= A_c \sin \omega_c t + \frac{2m}{2} A_c \sin \omega_m t + \sin \omega_c t$$

$$x_{AM}(t) = A_c \sin \omega_c t + \frac{m A_c}{2} \cos(\omega_c - \omega_m) t - \frac{m A_c}{2} \cos(\omega_c + \omega_m) t$$

Total power

$$P_T = \frac{\left(\frac{A_c}{\sqrt{2}}\right)^2}{R} + \frac{\left(\frac{A_c m}{2\sqrt{2}}\right)^2}{R} + \frac{\left(\frac{A_c m}{2\sqrt{2}}\right)^2}{R}$$

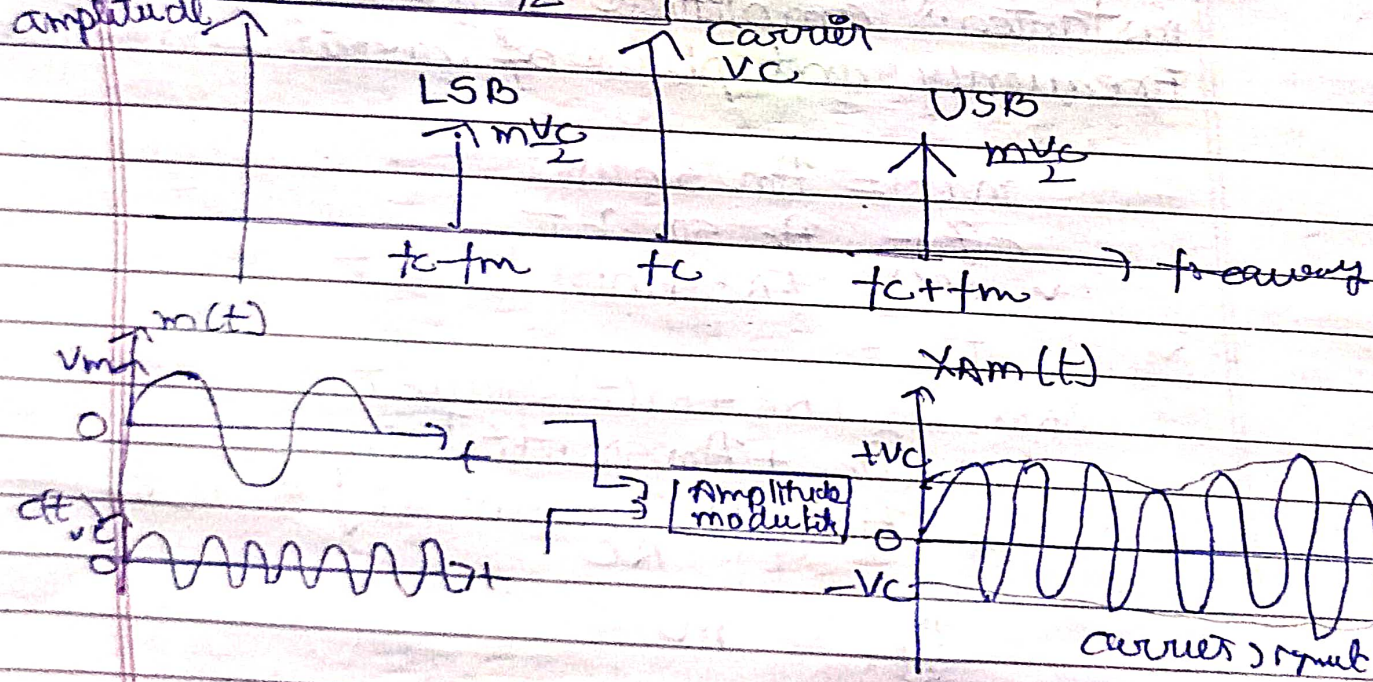
$$= \frac{\left(\frac{A_c}{\sqrt{2}}\right)^2}{R} \left[1 + \frac{m^2}{4} + \frac{m^2}{4}\right]$$

$P_T = P_c\left[1+\frac{m^2}{2}\right]$

$\eta = \frac{\text{Useful Power}}{\text{Total Power}} = \frac{\left(\frac{ACM}{\sqrt{2}}\right)^2 + \left[\frac{ACM}{\sqrt{2}}\right]^2}{P_c\left[1+\frac{m^2}{2}\right]}$

$= \frac{P_c\left[\frac{m^2}{4}+\frac{m^2}{4}\right]}{P_c\left[1+\frac{m^2}{2}\right]}$

$\eta = \frac{m^2/2}{1+m^2/2}$



(ii) AM radio transmitter radiator 6KW power when modulation % is 70%. Determine the carrier po

Ans $P_t = P_c\left[1+\frac{m^2}{2}\right]$

$P_t = 6KW$, $m = 0.70$

So, $P_c = \frac{P_t}{1+\frac{m^2}{2}} = \frac{6\times10^3}{1+0.49/2}$

$P_c = 4.82KW$

Q7 An audio frequency signal $5\sin 2\pi \times 500t$ is used to amplitude modulate of carrier of $25\sin 2\pi 10^5 t$ Calculate (i) Modulation index (ii) side band frequency (iii) Amplitude of each side band (iv) Bandwidth required (v) Total power (vi) Transmission efficiency.

Sol

$m(t) = 5\sin 2\pi \times 500t$

$c(t) = 25\sin 2\pi \times 10^5 t$

(i) $m = \frac{A_m}{A_c} = \frac{5}{25} = 0.5$

(ii) $f_c + f_m$ & $f_c - f_m$

$f_c = 10^5\ Hz = 100\ KHz$ $\quad f_m = 500\ Hz = 0.5\ KHz$

$f_c + f_m = 100 + 0.5 = 100.5\ KHz$

$f_c - f_m = 100 - 0.5 = 99.5\ KHz$

(iii) amplitude of side bands $= \frac{m \cdot A_c}{2}$

$= \frac{0.5 \times 25}{2} = 2.5V$

(iv) Bandwidth $= 2f_m = 2 \times 500$

$= 1\ KHz$

(v) $P_c = \frac{V_c^2}{2R}$ $\quad R = 1\Omega$ $\quad V_c = 25$

$P_c = \frac{(25)^2}{2 \times 1} = 312.50$ watt

$P_t = P_c\left[1 + \frac{m^2}{2}\right] = 312.50\left[1 + \frac{(0.2)^2}{2}\right] = 318.75$ watt

(vi) $\eta = \frac{m^2/2}{1 + m^2/2} = \frac{(0.2)^2/2}{1 + (0.2)^2/2} = \frac{0.04}{2 + 0.04} = 0.0196$

$\%\eta = 0.0196 \times 100$

$\%\eta = 1.96\ \%$

Q.5 (i) What is RADAR? Write down two applications of RADAR.

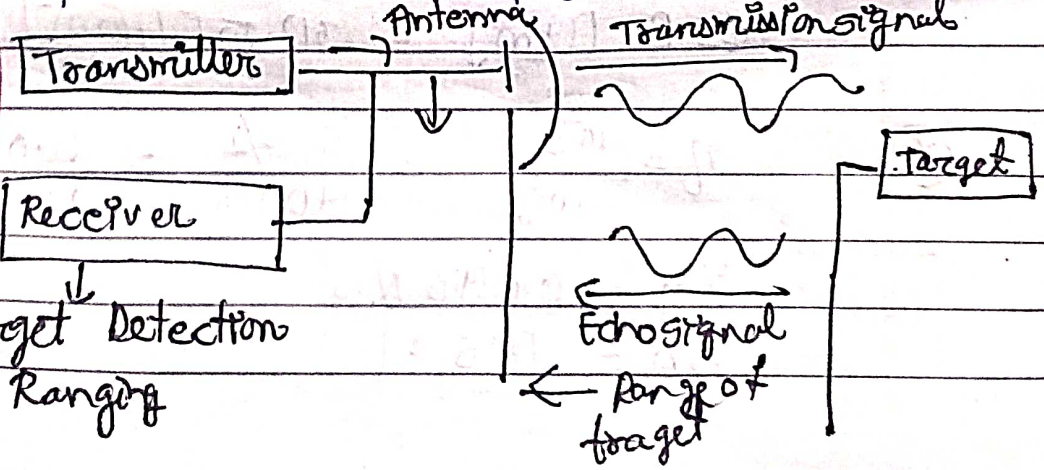
Ans) Radar is detection system that uses radio wave to determine the range angle or velocity of the object. It can be used to detect aircraft, ships, spacecraft, guide missiles

Element of Radar Communication System

1. Transmitter
2. Antenna
3. Receiver
4. Power supply

Radio waves from the transmitter, reflect off the object & return to the receiver, giving information about the objection location & speed

Transmitter of radar system emits radio waves in predetermined direction. When these signals meets on object, they are usually reflected in many directions. The signals reflected back towards the Radar receiver are used for detection purpose. The time taken by the radio signal to reach the destination of return back to the radio receiver



Radar Application :-

① In military application
② Air traffic control

(ii) Write short notes on Wireless Communication

Ans Wireless communication is the transmission of voice and data without cable or wires. In place of a physical connection data travels through electromagnetic signal broadcast from sending facilities to intermediate and end user device. The first wireless communication went on the air in the early 20th century using radiotechnology, which is radio communication using Morse code or other coded signal. Later on Modulation made it possible to transmit voice and music wirelessly, medium become known as radio, wireless transmitter use electromagnetic waves to carry voice