

Physics Notes

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Class:10+2

Unit: X

Topic: Communication System

SYLLABUS: UNIT-X

Elements of a communication system (block diagram only); bandwidth of signals (speech, TV and digital data); bandwidth of transmission medium. Propagation of electromagnetic waves in the atmosphere, sky and space wave propagation. Need for modulation. Production of detection of an amplitude-modulated wave.



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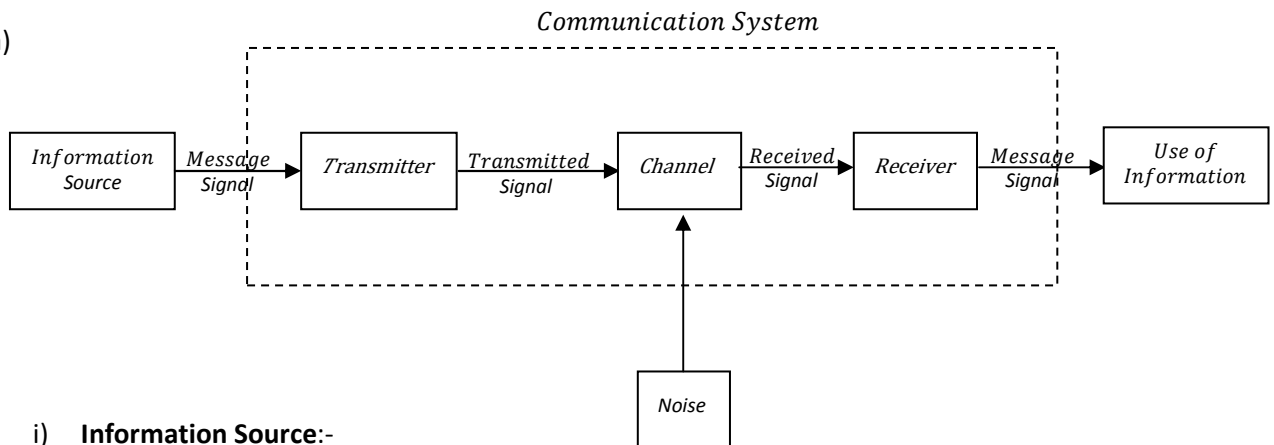
Q.1. Match the following:

Ans

I	II
1. Telegraph	Morse and Wheatstone
2. Telephone	Graham Bell
3. Wireless communication	Jagdish Chandre Bose and Marconi
4. Television	Johan Logi Baird
5. Internet	J.C.P. Licklider
6. W.W.W. (World wide web)	Tim Berners Lee

- Q2. a) Draw block Diagram (Scheme) of a generalized communication system and explain each of its component?
b) "Point to Point" and "Broadcast Communication".

Ans.a)



i) **Information Source:-**

Information source is a source of data/signal to be transmitted across communication channel. It may be analogous or digital in form of audio cassette, VCD, soft copy of a file.

ii) **Transmitter:-**

Transmitter converts the message signal into a form suitable for transmitting it through wire/wireless network.

iii) **Channel:-**

Channel is the media between the transmitter and receiver. It may be wireless or with wires.

iv) **Receiver:-**

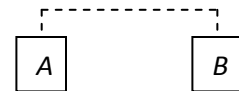
A receiver extracts the desired message signals from the received signals at the channel output.

v) **Noise:-**

Noise is unwanted signal.

b) **"Point to Point" and Broadcast Communication.**

In point to point communication, communication takes place over a link between a single transmitter and receiver.

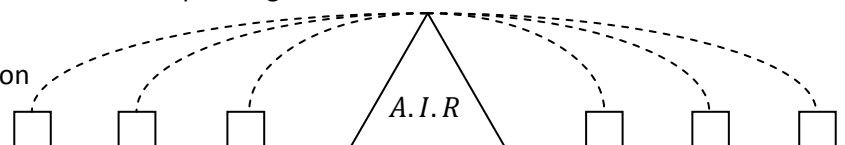


Example: Telephony

Broadcast Communication

There is large number of receivers corresponding to a single transmitter.

Example: Radio and Television



Q3. Define/Explain the following:-

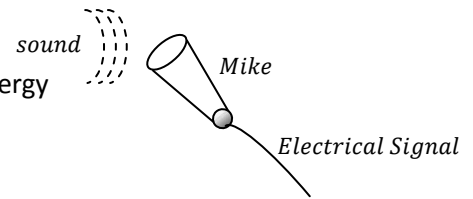
- | | |
|-----------------------|-------------------------|
| a) Transducer | g) Amplification |
| b) Signal | h) Range |
| c) Noise | i) Bandwidth |
| d) Transmitter | j) Modulation |
| e) Receiver | k) Demodulation |
| f) Attenuation | l) Repeater |

Ans.

a) Transducer:-

Transducer is a device that converts one form of energy into another.

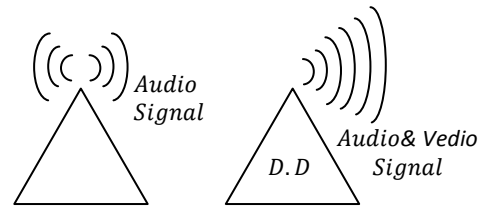
Example:



b) Signal:-

Information converted in electrical form and suitable for transmission.

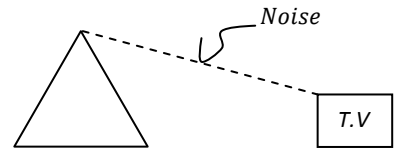
Example: Signal can be analog or digital



c) Noise:-

Noise is unwanted signal that disturbs the transmission and processing of message signal in a communication system.

Example: Lighting stroke causes disturbance on Television set. Lighting signal is a source of noise.



d) Transmitter:-

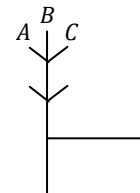
Transmitter processes the incoming message signal so as to make it suitable for transmission through a channel and subsequent reception.

Example: FM Radio transmitter transmits the signal so that it can travel up to FM radio and easily demodulated by FM radio.

e) Receiver:-

A receiver extracts the desired message signal from the received signals at the channel output.

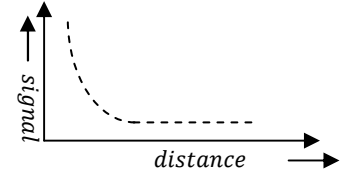
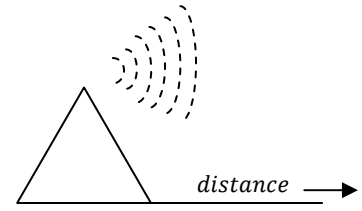
Example: A radio Antenna receives signals from three stations say A, B and C.



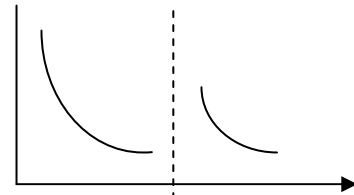
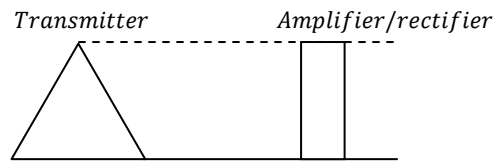
f) **Attenuation:-**

The loss of strength of a signal while propagating through a medium is known as attenuation.

Example: As we move away from tower signal strength decreases.

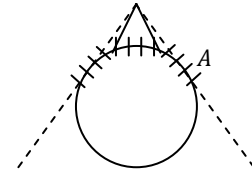
g) **Amplification:-**

It is the process of increasing the amplitude of a signal using an electronic circuit called the *Amplifier*.

h) **Range:-**

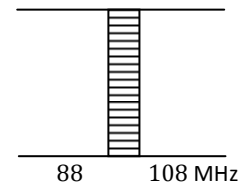
It is the largest distance between the source and destination up to which the signal received with sufficient strength.

Example:

i) **Bandwidth:-**

Band width refers to frequency range over which an equipment operates or the portion of the spectrum occupied by the signal

FM radio $88 < < 108$ MHz

j) **Modulation:-**

Modulation is process of superimposing message signal on carrier wave

Example: Amplitude modulation
Frequency Modulation

k) **Demodulation:-**

It is the reverse of modulation process of retrieval of information from the carrier wave at the receiver.

Example: AM receiver separates signal from carrier wave through this process of demodulation.

l) **Repeater:-**

A Repeater picks up the signal from the transmitter amplifier and retransmits it.

Q4. Find Range of a T.V. tower of height h (say 500m)?

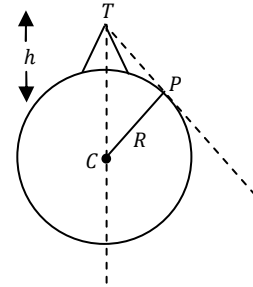
Ans. Find range TP = ?

In triangle CPT

$$\begin{aligned}(CT)^2 &= (CP)^2 + (PT)^2 \\(R + h)^2 &= R^2 + (TP)^2 \\(TP)^2 &= (R + h)^2 - R^2 \\&= R^2 + h^2 + 2Rh - R^2 \\&= h^2 + 2Rh\end{aligned}$$

TP	$\simeq \sqrt{2Rh}$	(As $h \ll R$)
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$$\text{Range} \propto \sqrt{\text{height}}$$



Q5. Write Band width for various signals?

Ans. Speech signal 300 Hz < < 3100 Hz

(Bandwidth = 2800 Hz)

Audio Signal 20 Hz < < 20 KHz

(Bandwidth \simeq 20 KHz)

Video Signal (Television) $\left(\begin{array}{c} \text{(Bandwidth} \simeq 6 \text{ MHz)} \\ < \text{Range} < \end{array} \right)$

11

Q6. What is the need for modulation?

Ans.

13

- Q7. Explain propagation of Electromagnetic Waves i.e.**
- a) Ground Wave Propagation**
 - b) Sky Wave Propagation**
 - c) Space Wave Propagation.**

Ans.

Q8. Explain the following with respect to AM

- a) **Amplitude Modulation?**
- b) **Modulation index?**
- c) **Side bands significance?**

Ans.

- a) Amplitude modulation is a modulation in which amplitude of carrier wave varies in accordance with message signal.

$$y = A \sin \omega_c t$$

↓
Amplitude varies in accordance with message

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

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

$$= A_c \sin \omega_c t + \frac{A_m \cdot A_c}{A_c} \sin(\omega_m t) \sin(\omega_c t)$$

$$C_m(t) = A_c \sin \omega_c t + \mu A_c \sin(\omega_m t) \sin(\omega_c t)$$

$$C_m(t) = A_c \sin \omega_c t + \mu A_c \sin(\omega_m t) \sin(\omega_c t)$$

- b) **Modulation Index, μ :**

$$\mu = \frac{A_m}{A_c} \quad \mu \leq 1$$

- c) **Side Bands:**

$$C_m(t) = A_c \sin \omega_c t + \frac{\mu A_c}{2} [2 \sin(\omega_m t) \sin(\omega_c t)]$$

↓
↓
 B A

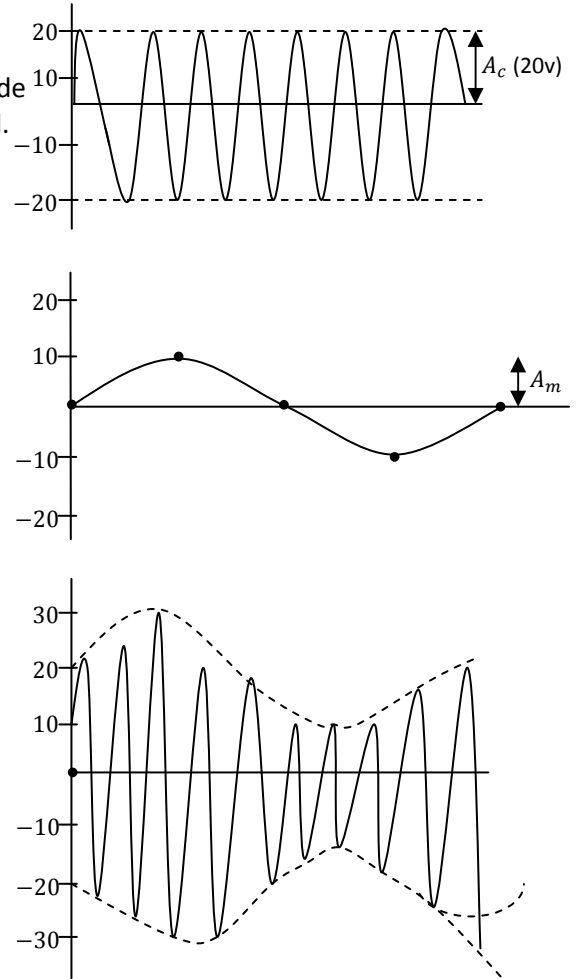
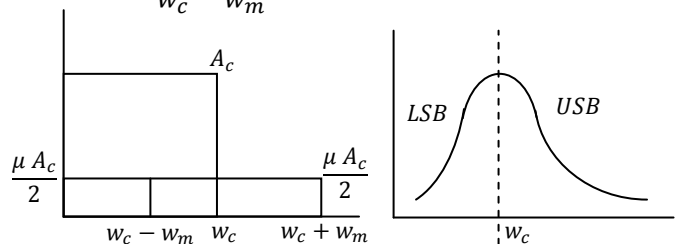
$$[2 \sin A \sin B = \cos(A - B) - \cos(A + B)]$$

$$C_m(t) = A_c \sin \omega_c t + \frac{\mu A_c}{2} \{ \cos(\omega_c t - \omega_m t) - \cos(\omega_c t + \omega_m t) \}$$

$$= A_c \sin \omega_c t + \frac{\mu A_c}{2} \left\{ \cos \underbrace{[(\omega_c - \omega_m)t]}_{\omega_c - \omega_m} - \frac{\mu A_c}{2} \cos \underbrace{[(\omega_c + \omega_m)t]}_{\omega_c + \omega_m} \right\}$$

↓
↓
↓
 ω_c $\omega_c - \omega_m$ $\omega_c + \omega_m$

Components of wave with frequency $(\omega_c - \omega_m)$ and $(\omega_c + \omega_m)$ are termed as side bands.



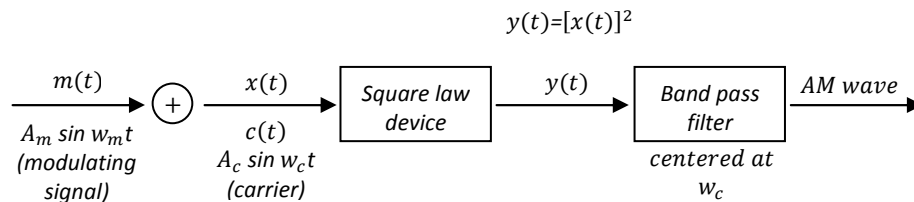
Q9. Production of AM waves?

Ans. Step 1.

$$\begin{aligned} x(t) &= c(t) + m(t) \\ &= A_c \sin(\omega_c t) + A_m \sin(\omega_m t) \end{aligned}$$

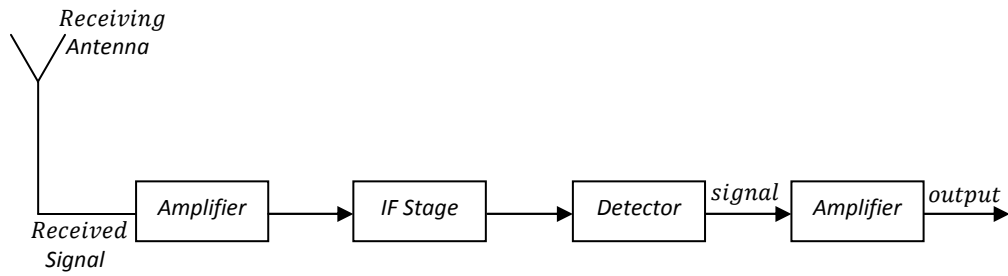
Step 2.

$$\begin{aligned} y(t) &= [x(t)]^2 \\ &= A_c^2 \sin^2(\omega_c t) + A_m^2 \sin^2(\omega_m t) \\ &\quad + 2A_c A_m \sin \omega_c t \cdot (\sin \omega_m t) \\ y(t) &= \frac{A_c^2}{2} (1 - \cos 2(\omega_c t)) + \frac{A_m^2}{2} (1 - \cos 2(\omega_m t)) + 2A_c A_m \\ &\quad \cos [\omega_c t - \omega_m t] - \cos [\omega_c t + \omega_m t] \\ &= \frac{A_c^2}{2} - \frac{A_c^2}{2} \cos 2(\omega_c t) + \frac{A_m^2}{2} - \frac{A_m^2}{2} \cos 2(\omega_m t) + 2A_c A_m \\ &\quad \cos [\omega_c t - \omega_m t] - 2A_c A_m \cos [\omega_c t + \omega_m t] \end{aligned}$$



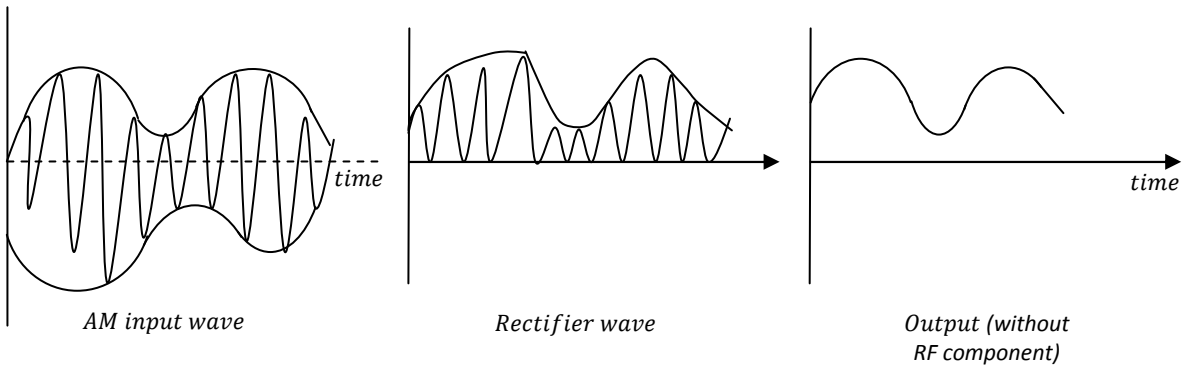
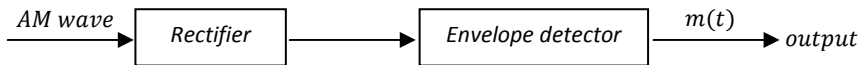
Q10. Draw the block diagram of a detector for AM signal.

Ans.



Detection is the process of recovering the modulating signal from the modulated carrier wave.

To obtain the original message signal $m(t)$ of angular frequency ω_m .



The modulated signal is passed through the rectifier to produce the output. The envelope of signal is the message signal. In order to retrieve $m(t)$, the signal is passed through an envelope detector.