CLASS – 12

WORKSHEET- COMMUNICATION SYSTEMS

(1marks Questions)

1. Name the types of communication systems according to the mode of transmission.

Sol. (i) Analog communication

(ii) Digital communication.

2. Name the type of communication in which the signal is a discrete and binary coded version of the message of information.

Sol. Digital communication is that type of the communication system in which the signal is discrete and has binary coded version of message or information.

3. What is the purpose of modulating a signal in transmission?

Sol. The amplitude of the baseband signal is transferred to the high-frequency carrier. Such a higher frequency carrier is able to travel much farther than the baseband signal. Therefore, modulation can be defined as the process of superimposing a low-frequency signal on a high-frequency carrier signal.

4. What type of modulation is required for television broadcast?

Sol. Frequency modulation is required for television broadcast.

5. Which frequency modulation preferred over amplitude modulation for transmission of music?

Sol. FM: It is short for frequency modulation. FM transmission takes place by modulating the frequency of the carrier wave. The sound quality is much superior to AM broadcast and that is a major reason why FM stations prefer to be only-music broadcasters.

6. Name type of modulation scheme preferred for digital communication.

Sol. Pulse code modulation (PCM) is preferred for digital modulation. PCM represents the sampled analog signals in a digitalized manner.

7. What type of modulation is required for commercial broadcast of voice signals?

Sol. Amplitude modulation is required for commercial broadcast of voice signals.

8. Why is shortwave band used for long distance radio broadcast?

Sol. Long distance radio broadcasts use short-wave bands because they can be reflected by the ionosphere of the earth's atmosphere and thus can be send to longer distances.

9. Why is ground wave transmission of signals restricted to a frequency of 1500 kHz?

Sol. The energy of the radio waves decreases as they travel over the surface of the earth due to the conductivity and permittivity of the earth's surface. Attenuation increases with the increase in frequency. Therefore, the ground waves are limited to frequency of 1.5 MHz (1500 kHZ) or wavelength of 200 m.

10. Name an appropriate communication channel needed to send a signal of bandwidth 100 kHz over a distance of 8 km.

Sol. Ground-wave propagation is used to send a bandwidth 100 kHz over a distance of 8 km .

11. What is antenna?

Sol. An antenna is a metallic structure that captures and/or transmits radio electromagnetic waves. Antennas come in all shapes and sizes from little ones that can be found on your roof to watch TV to really big ones that capture signals from satellites millions of miles away.

12. What should be the length of dipole antenna for a carrier wave of frequency 6×10^8 Hz?

Sol. 0.125m should be the length of dipole antenna for a carrier wave of frequency 6×10^8 Hz.

13. How does power radiated by an antenna vary with wavelength?

Sol. To transmit a signal an antenna is needed. Power radiated by a linear antenna of length l is $P \propto (1/\lambda)^2$ where λ is the wavelength of the signal.

14. Give one difference between FAX and e-mail systems of communication.

Sol. Fax is the method of sending and receiving documents containing texts using telephone lines whereas email is a method of sending or receiving electronic messages over the internet.

15. Write the main function of a modem.

Sol. A modem transmits data by modulating one or more carrier wave signals to encode digital information, while the receiver demodulates the signal to recreate the original digital information. The goal is to produce a signal that can be transmitted easily and decoded reliably.

16. Which of the following frequencies will be suitable for beyond-the horizon communication using sky waves?

(1) 10 kHz (2) 10 MHz (3) 1 GHz (4) 1000 GHz

Ans. (2)

The high energy signal waves (1 GHz − 1000 GHz) penetrate the ionosphere and escape. 10 MHz frequencies get reflected easily from the ionosphere. Hence, signal waves of such frequencies are suitable for beyond-the-horizon communication.

17. Frequencies in the UHF range normally propagate by means of :
(1) Ground Waves (2) Sky Waves (3) Surface Waves (4) Space Waves

Sol. (4)

18. Digital signals
(i) Do not provide a continuous set of values
(ii) Represent value as discrete steps
(iii) Can utilize binary system
(iv) Can utilize decimal as well as binary systems
State which statement(s) are true?
(a) (1), (2) and (3) (b) (1) and (2) only
(c) All statements are true (d) (2) and (3) only

Sol. (c), Digital signals cannot utilize decimal system which represents a continuous sett fo values.

(2marks Questions)

19. What should be the frequency carrier wave with reference to message signal for the process of modulation?

Sol. Modulation is a process employed to superimpose a carrier wave with a signal wave. A message signal of frequency 10 KHz and peak voltage of 10 volts is used to modulate a carrier wave of frequency 1 MHz and peak voltage of 20 volts.

20. A transmitting antenna at the top of a tower has height of 36m and the height of the receiving antenna is 49m. What is the maximum distance between them, for satisfactory communicating the LOS mode? (Radius of the earth = 6400km)

Sol. Given height of Trasmitting antenna (hT)=32m, Reciveing antenna (hR)=50m

and radius of earth (RE)=6.4×10^6m

In line of sight (LOS) communication, maximum distance of communication (dmax) is given by

$d_{max}= \sqrt{(2h_TR_E)} + \sqrt{(2h_RR_E)}$

putting values ,

$d_{max}=\sqrt{(2\times32\times6.4\times10^6)}+\sqrt{(2\times50\times6.4\times10^6)}$

$=(\sqrt{409.6}+\sqrt{640})\times10^3$m

$d_{max}\simeq45.54$ km

21. A TV tower has a height of 400m at a given place. Calculate its coverage range, if the radius of the earth is 6400km

Sol. Here h_t = 400m, R = 6400km = 6400×1000m

Therefore, coverage range, dm = $\sqrt{2Rh_t} = \sqrt{2\times6400\times1000\times400}$= 71.55km.

22. Why sky wave propagation of electromagnetic wave cannot be used for TV transmission?

Sol. TV signals have high frequency range of 103 to 200MHz. Ionospheric layers do not reflect back such high frequency signals. Hence. sky waves cannot be used for transmission of TV signals.

23. Suggest two methods by which the range of TV transmission can be increased.

Sol. The range of transmission of signals by a TV tower can be increased by the following ways: (i) By increasing the height of the transmission tower. (ii) By increasing the height of the receiving antenna, so that it may directly intercept the signal from the transmitting antenna.

24. What should be the length of an antenna in comparison to the wavelength of RF signal applied?

Sol. For efficient radiation and reception, the height of transmitting and receiving antennas should be comparable to a quarter of wavelength of the frequency used. So for efficient transmission of signals of wavelengths λ the minimum length of antenna should be $\lambda/4$.

25. Derive an expression for the maximum range up to which TV signals can be received on earth's surface

Sol. For large TV coverage, the transmission of TV signal is done from a tall antenna. Consider a TV antenna OP of height h. The transmitting signals cannot be received beyond points R_1 and R_2.

This is due to curvature of earth.

Clearly, OR_1 and OR_2 are the maximum distances, from the antenna, upto which the transmission signal can be received.

Let $OR_1 = OR_2 = d$ [d is half the total range]

The relation between height h of the TV antenna and the maximum distance d upto which the TV signal can be received can be derived on the basis of geometrical considerations.

From right – angled triangle CR_2P, $CP_2 = CR_22 + PR_{22}$ …. (1)

In right – angled triangle POR2, PR22 = h2 + d2

[Note that $\angle POR_2$ can be taken as right angle]

Also, $CR_2 = CO = R$ and $CP = R + h$

From Equation (1) $(R + h)^2 = R^2 + (h^2 + d^2)$ $R^2 + h^2 + 2Rh = R^2 + h^2 + d^2$ or $d = \sqrt{2Rh}$

It is clear from this equation that if h is large, d will be large. This explains as to why the television broadcasts are made from tall antennas.

26. Is it necessary for a transmitting antenna to be at the same height as that of the receiving antenna for line-of-sight communication? A TV transmitting antenna is 81m tall. How much service area can it cover if the receiving antenna is at the ground level?

Sol. Line-of-sight communication means that there is no physical obstruction between the transmitter and the receiver. In such communication, it is not necessary for the transmitting and receiving antennas to be at the same height.

h=81 m, R=6.4×10^6 m

For range, d=$\sqrt{2Rh}$

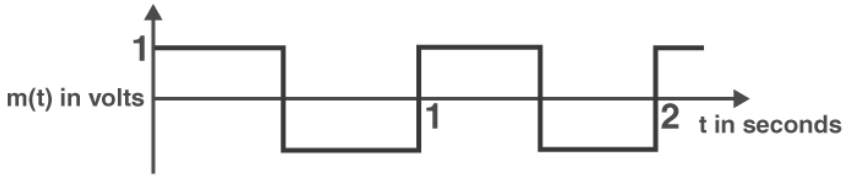
A=πd^2=3256 km^2

27. A carrier wave of peak voltage 12 V is used to transmit a message signal. What should be the peak voltage of the modulating signal in order to have a modulation index of 75%?

Sol. As $\mu = A_m/A_c$

Therefore $A_m = \mu A_c = (75/100) \times 12V = 9V$

28. A modulating signal is a square wave, as shown in the figure.

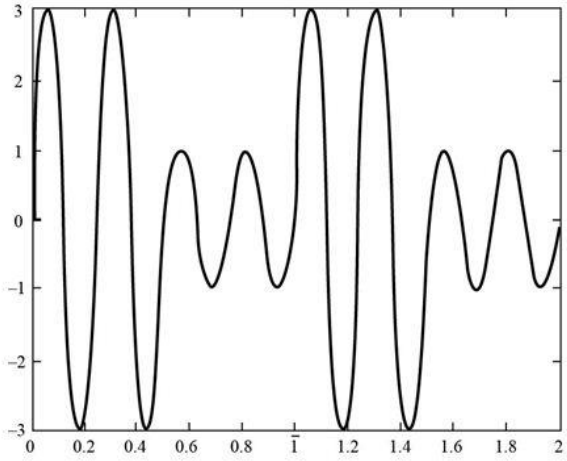


The carrier wave is given by c(t)=2sin(8πt)volts.

(1) Sketch the amplitude modulated waveform

(2) What is the modulation index?

Sol. (1) The amplitude modulated wave is shown below:



(2) $\mu = A_m/A_c = 1V/2V = 0.5$.

29. For an amplitude modulated wave, the maximum amplitude is found to be 10V while the minimum amplitude is found to be 2V. Determine the modulation index, μ. What would be the value of μ if the minimum amplitude is zero volts?

Sol. $\boldsymbol{\mu = \frac{A_{max}-A_{min}}{A_{max}+A_{min}} = \frac{10-2}{10+2} = \frac{8}{12} = \frac{2}{3}}$

If $A_{min} = 0$, then $\mu = A_{max}/A_{max} = 1$
This is true for all values of A_{max}

.

(3 marks Questions)

30. How do we make the choice of a communication channel? A message signal has a bandwidth of 5MHz. Suggest a possible communication channel for its transmission.

Sol. Select the best communication channels at work in 3 steps
Step 1: Identify what kind of message you're sending. ...
Step 2: Consider your company's culture around communication. ...
Step 3: Pick a delivery method based on your audience.

For A message signal has a bandwidth of 5MHz.

The suitable communication channel is coaxial cables.

31. Distinguish between analog and digital communication. Write any two modulation techniques employed for the digital data. Describe briefly one of the techniques used.

Sol. Analog and digital signals are the types of signals carrying information. The major difference between both signals is that the **analog signals have continuous electrical signals, while digital signals have non-continuous electrical signals**.
Understanding Modern Digital Modulation Techniques

- Amplitude Shift Keying (ASK) and Frequency Shift Keying (FSK) ...
- Binary Phase Shift Keying (BPSK) And Quadrature Phase Shift Keying (QPSK) ...
- Data Rate And Baud Rate. ...
- Multiple Phase Shift Keying (M-PSK) ...
- Quadrature Amplitude Modulation (QAM) ...
- Amplitude Phase Shift Keying (APSK)

Linear Predictive Coding LPCLPC is a tool which represents digital speech signals in linear predictive model. This is mostly used in audio signal processing, speech synthesis, speech recognition, etc.

Linear prediction is based on the idea that the current sample is based on the linear combination of past samples. The analysis estimates the values of a discrete-time signal as a linear function of the previous samples.

32. What is digital symbol? Explain the function of modem in data communication. Write two advantages of digital communication.

Sol. The Symbol Digit Modalities Test uses essentially the same method, except in reverse; instead of drawing symbols that match digits.

A modem transmits data by modulating one or more carrier wave signals to encode digital information, while the receiver demodulates the signal to recreate the original digital information. The goal is to produce a signal that can be transmitted easily and decoded reliably.

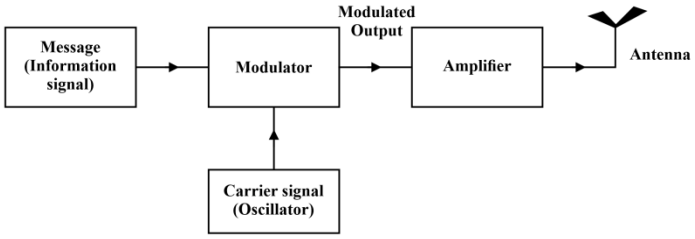
Advantages of Digital Communication: The effect of distortion, noise, and interference is much less in digital signals as they are less affected. Digital circuits are more reliable. Digital circuits are easy to design and cheaper than analog circuits.

33. What is modulation? Explain the need of modulating a low frequency information signal.

Sol. Modulation is the process of converting data into radio waves by adding information to an electronic or optical carrier signal. Modulation is simply a widely used process in communication systems in which a very high-frequency carrier wave is used to transmit the low-frequency message signal so that the transmitted signal continues to have all the information contained in the original message signal.

34. Define the term 'modulation'? Explain with the help of a block diagram, how the process of modulation is carried out in radio broadcasts.

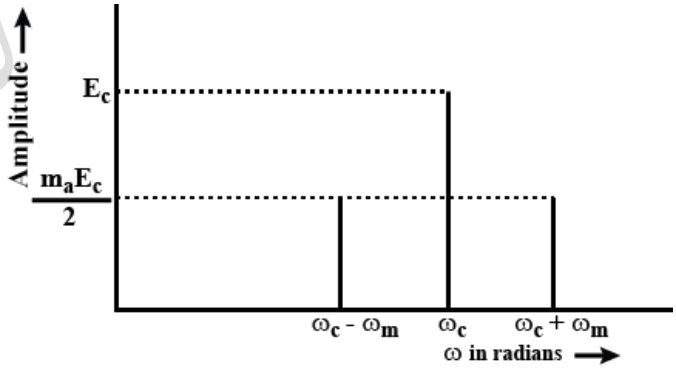
Sol. Modulation is the process of converting data into radio waves by adding information to an electronic or optical carrier signal.



The block diagram shows the process of modulation. The low frequency message modulating signal and high frequency carrier wave obtained from an oscillator are given as inputs to the modulator. The modulator now produces the modulated output. This modulated output is amplified by an amplifier and then transmitted through the antenna.

35. Draw the plot variation of amplitude versus ω for an amplitude modulated wave. Define modulation index. State its importance for effective amplitude modulation.

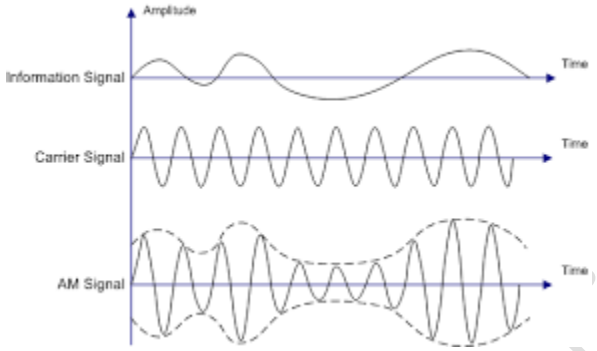
Sol.



Modulation index is defined as the ratio of the fundamental component amplitude of the line-to-neutral inverter output voltage to one-half of the available DC bus voltage.

36. What is ‘amplitude modulation’? Represent the process graphically. Write its advantages and disadvantages.

Sol. Amplitude modulation: The modulation of a wave by varying its amplitude, used especially as a means of broadcasting an audio signal by combining it with a radio carrier wave.



Advantages of Amplitude Modulation

- The cost of amplitude modulation is low
- Amplitude modulated signals are reflected by the earth from the ionosphere layer
- Thus, they travel a long distance and cover a wider area
- Required carrier frequency is low
- It requires a simple transmitter and receiver
- Thus transmission and reception of an audio signal are less cumbersome
- Demodulation of amplitude-modulated signals is less complex due to the use of a circuit having few components

Disadvantages of Amplitude Modulation

- Amplitude modulated signals are highly susceptible to peripheral noises
- Receivers of these signals find it difficult to distinguish between signals and noises
- Thus, the quality of the audio signal is of poor standard
- If the amplitude modulated signal is weak, the receiver requires a complex arrangement
- Amplitude modulation is less efficient in terms of bandwidth usage
- The bandwidth of the modulated signal is twice the frequency of the signal wave
- Amplitude modulation is also less efficient in terms of power usage
- Only the power in the sidebands is used

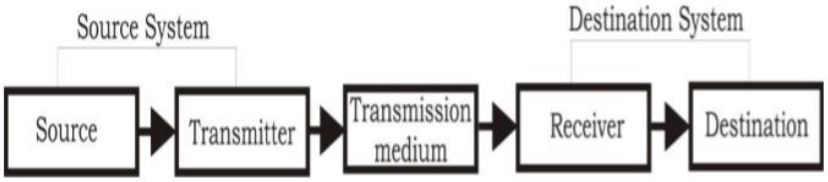
37. Distinguish between frequency modulation and amplitude modulation. Why is an FM signal less susceptible to noise than an AM signal?

Sol. The main difference between both modulations is that in frequency modulation, the carrier wave frequency is modified as per the transmit data. In contrast, in amplitude modulation, the carrier wave is modified according to the data.

In FM transmission, a message signal is a form of carrier frequency change. During the modulation process, the noise is amplitude modulated. Since it only changes the amplitude of the carrier, it does not damage the message signal. Therefore, FM signals are less susceptible to noise than AM signals.

38. Name the device used for data transmission from one computer to another. Justify the name. Using the device draw the block diagram for data communication and explain it briefly

Sol. Routers help transmit packets to their destinations by charting a path through the sea of interconnected networking devices using different network topologies. Routers are intelligent devices, and they store information about the networks they're connected to.



The above figure shows the basic block diagram of a typical data communication system**.** This can further be broken down into three; the source system, transmission system, and destination system.

39. Consider an optical communication system operating at λ □ 800nm. Suppose only 1% of the optical source frequency is the available channel bandwidth for optical communication. How many channels can be accommodated for transmitting (a) audio signals requiring a bandwidth of 8kHz, (b) video TV signals requiring an approximate bandwidth of 8 MHz? Support your answer with suitable calculations..

Sol. (a) Optical source frequency $f=c/\lambda = 3\times10^{8}/(800\times10^{-9})=3.8\times10-14$ Hz

Bandwidth of channels (1% of above) =3.8×1012 Hz

Number of channels = Total bandwidth of channel/Bandwidth of needed per channel

Number of channels for audio signal $=(3.8\times10^{12})/(8\times10^{3}) \sim 4.8\times10^{8}$

(b) Optical source frequency = $f\,(c/\lambda) = [(3 \times 10^{8}) / (800 \times 10^{-9})] = 3.8 \times 10^{14}$Hz

BW of channel = 1% of f

∴ BW of channel = 3.8×10^{12}Hz

No. of channels = [(Total BW of channel) / (BW needed per channel)]

$= [(3.8 \times 10^{14}) / (4.5 \times 10^{6})]$ ∴ No. of channels = 8.4×10^{5}

40. Give reasons for the following:
(a) Long distance radio broadcasts use short wave bands.
(b) The small ozone layer on top of stratosphere is crucial for human survival.

(c) satellites are used for long distance TV transmission.

Sol. (a) Long distance radio broadcasts use shortwave bands because only these bands can be refracted by the ionosphere.

(b) The small ozone layer on the top of the atmosphere is crucial for human survival because it absorbs harmful ultraviolet radiations present in sunlight and prevents it from reaching the Earth's surface.

(c) It is necessary to use satellites for long distance TV transmissions because television signals are of high frequencies and high energies. Thus, these signals are not reflected by the ionosphere. Hence, satellites are helpful in reflecting TV signals. Also, they help in long distance TV transmissions.

41. Explain the following: (i) Ground waves (ii) Space waves (ii) Sky waves.

Sol. If wave travels directly along the Earth from one point to another is called ground wave.

2. It is the mode of wave propagation in which the radio waves emitted from the transmitter antenna reach the receiving antenna through space. These radio waves are called space waves

3. If the wave is directed towards the sky and after reflection from ionosphere of Earth's atmosphere reaches the desired location on Earth is called sky wave.

42. Due to economic reasons, only the upper sideband of an AM wave is transmitted, but at the receiving station, there is a facility for generating the carrier. Show that if a device is available which can multiply two signals, then it is possible to recover the modulating signal at the receiver station.

Sol. Due to economic reasons, only the upper side band of an AM wave is transmitted, but at the receiving station, there is a facility for generating the carrier. Show that if a device is available which can multiply two signals, then it is possible to recover the modulating signal at the receiver station.

43. Draw a block diagram of a simple amplitude modulation. Explain briefly how amplitude modulation is achieved?

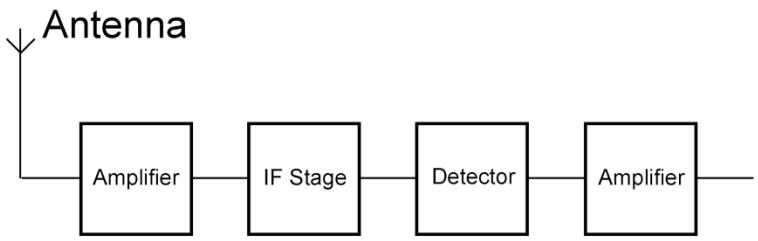
Sol. Same as figure in 36.

Amplitude modulation is a process by which the wave signal is transmitted by modulating the amplitude of the signal. It is often called AM and is commonly used in transmitting a piece of information through a radio carrier wave. Amplitude modulation is mostly used in the form of electronic communication.

44. Explain the working of amplitude demodulator at receiver end with the help of block diagram

Sol. AM receiver – Amplitude modulation receiver is electrical equipment that receives an amplitude modulated wave as input and produces the original signal as an output.

The block diagram of an AM receiver is shown below



The basic description of all the parts of the AM receiver is as follows
Receiving antenna – A receiving antenna functions opposite to a transmission antenna and receives the amplitude-modulated wave and converts it into electric current and feeds it to the amplifier.
Amplifier – An amplifier is a piece of equipment that is used to amplify the signal received by the antenna.
IF stage – In the intermediate-frequency amplifier stage the intermediate frequencies of the amplified signals are filtered and amplified before feeding it the demodulator, this makes the process of demodulation easier.
Detector – It is a device or circuit, used to extract the desired signal from the carrier wave, a process called demodulation
Amplifier- It is a component that amplifies the low power electric signals that have become low after the IF stage and the process of demodulation.
This signal can now be used for the desired device (maybe a TV or a radio).