1. A basic communication system consists of
(1) receiver
(2) information source
(3) user of information
(4) transmitter
(5) channel
Choose the correct sequence in which these are arranged in a basic communication system.
(a) 12345  (b) 24513  (c) 24531  (d) 25143

2. Which of the following is not a transducer?
(a) Microphone  (b) Loudspeaker
(c) Earphone  (d) Amplifier

3. If the maximum amplitude of an amplitude modulated wave is 20 V and the minimum amplitude is 4 V, then the modulation index is
(a) $\frac{1}{3}$  (b) $\frac{3}{2}$  (c) $\frac{2}{3}$  (d) $\frac{1}{5}$

4. Which of the following statements is correct?
(a) Pulse position denotes the time of rise or fall of the pulse amplitude.
(b) Modulation index $m$ is kept $\geq 1$ to avoid distortion.
(c) The audible range of frequencies is 20 Hz to 200 MHz.
(d) In amplitude modulation, the bandwidth is thrice the modulating frequency.

5. AM is used for broadcasting because
(a) it requires less transmitting power compared with other systems.
(b) it is more noise immune than other modulation systems.
(c) its use avoids receiver complexity.
(d) no other modulation system can provide the necessary bandwidth faithful transmission.

6. A transmitting antenna of height 20 m and the receiving antenna of height $h$ are separated by a distance of 40 km for satisfactory communication in line-of-sight mode. Then the value of $h$ is (Radius of the earth is 6400 km)
(a) 20 m  (b) 40 m  (c) 45 m  (d) 50 m

7. Which of the following would produce analog signals?
(1) Light pulse.
(2) Musical sound due to a vibrating sitar string.
(3) Output of a NOR gate.
(4) A vibrating tuning fork.
(a) 1 and 3   (b) 2 and 4
(c) 1, 2 and 3  (d) All

8. Identify the correct match from the following.
(a) Half duplex – Mobile phone device
(b) Full duplex – Modulator and demodulator
(c) Modem – Walky talky
(d) Fax – Transmission and reproduction of documents at a distant place
9. A message signal of frequency 10 kHz and peak voltage of 10 V is used to modulate a carrier of frequency 1 MHz and peak voltage of 20 V. Then the modulation index and the side band frequencies respectively are
(a) 0.05 and (1 ± 0.01) MHz  
(b) 0.5 and (1 ± 0.01) MHz  
(c) 0.05 and (1 ± 0.005) MHz  
(d) 0.5 and (1 ± 0.005) MHz

10. A diode AM detector with the output circuit consisting of \( R = 1 \, \text{M}\Omega \) and \( C = 1 \, \text{pF} \) would be more suitable for detecting a carrier signal of
(a) 0.1 MHz  
(b) 0.5 MHz  
(c) 1 MHz  
(d) 10 MHz

11. Of the following which is preferred modulation scheme for digital communication?
(a) Pulse Amplitude Modulation (PAM)  
(b) Pulse Position Modulation (PPM)  
(c) Pulse Width Modulation (PWM)  
(d) Pulse Code Modulation (PCM)

12. Match the List I with List II and select the correct answer using the codes given below the lists.

<table>
<thead>
<tr>
<th>List I (Name of Service)</th>
<th>List II (Frequency band)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P. AM broadcast</td>
<td>1. 3.7-4.2 GHz</td>
</tr>
<tr>
<td>Q. FM broadcast</td>
<td>2. 420-890 MHz</td>
</tr>
<tr>
<td>R. UHF TV</td>
<td>3. 88-108 MHz</td>
</tr>
<tr>
<td>S. Downlink of satellite communication</td>
<td>4. 540-1600 kHz</td>
</tr>
</tbody>
</table>

Codes:  
P Q R S  
(a) 3 4 1 2  
(b) 4 3 2 1  
(c) 2 1 3 4  
(d) 1 2 4 3

13. The block diagram of a detector for AM signal is as shown in the figure. Identify the boxes X and Y.

14. In TV broadcasting both picture and sound are transmitted simultaneously. In this
(a) audio signal is frequency modulated and video signal is amplitude modulated.  
(b) both audio and video signals are frequency modulated.  
(c) audio signal is amplitude modulated and video signal is frequency modulated.  
(d) both audio and video signals are amplitude modulated.

15. Which of the following waves are used for satellite communication?
(a) Ground  
(b) Space  
(c) Sound  
(d) Sky

16. Which of the following is an example of point-to-point mode of communication?
(a) Internet  
(b) Radio  
(c) Telephony  
(d) TV

17. In an amplitude modulated wave for audio frequency of 1000 Hz, the appropriate carrier frequency will be
(a) 10 Hz  
(b) 100 Hz  
(c) 1 kHz  
(d) 1 MHz

18. A 1000 kHz carrier wave is modulated by an audio signal of frequency range 500-5000 Hz. Then the bandwidth of the channel is
(a) 10 kHz  
(b) 20 kHz  
(c) 25 kHz  
(d) 50 kHz

19. The sky wave propagation is suitable for radiowaves of frequency
(a) upto 3 MHz  
(b) from 3 MHz to 20 MHz  
(c) from 3 MHz to 30 MHz  
(d) from 3 MHz to 50 MHz

20. In the daytime, ionosphere consists of
(a) D, E, and F\(_1\) layers only  
(b) E, F\(_1\) and F\(_2\) layers only  
(c) E and F\(_2\) layers only  
(d) D, E, F\(_1\), and F\(_2\) layers
21. How many AM broadcast stations can be accommodated in a 100 kHz bandwidth if the highest frequency modulating a carrier is 5 kHz?
(a) 5   (b) 10   (c) 15   (d) 20

22. A radiostation has two channels. One is AM at 1020 kHz and the other FM at 89.5 MHz. For good results you will use
(a) longer antenna for the AM channel and shorter for the FM.
(b) shorter antenna for the AM channel and longer for the FM.
(c) same length antenna will work for both.
(d) information given is not enough to say which one to use for which.

23. What should be the length of the dipole antenna for a carrier wave of frequency 300 MHz?
(a) 0.5 m   (b) 1 m   (c) 1.5 m   (d) 2 m

24. A message signal of angular frequency $\omega_m$ is superposed on a carrier wave of angular frequency $\omega_c$ to get an amplitude modulated wave (AM). The angular frequency of the AM wave will be
(a) $\omega_m$   (b) $\omega_c$   (c) $\frac{\omega_c + \omega_m}{2}$   (d) $\frac{\omega_c - \omega_m}{2}$

25. The radiating power of a linear antenna of radiating length $l$ for a wavelength $\lambda$ is proportional to
(a) $\frac{l}{\lambda}$   (b) $\frac{l^2}{\lambda^2}$   (c) $\frac{l}{\lambda^2}$   (d) $\frac{l^2}{\lambda}$

26. A ground receiver station is receiving a signal at 5 MHz and transmitted from a ground transmitter at a height of 300 m located at a distance of 100 km. The signal is coming via (Radius of earth = $6.4 \times 10^6$ m, $N_{\text{max}}$ of ionosphere = $10^{12}$ m$^{-3}$)
(a) sky wave
(b) space wave
(c) satellite communication
(d) all of these

27. An amplitude modulated wave is as shown in figure. The value of peak carrier voltage and peak information voltage respectively are

- $V_c$ = 10 V, $V_m$ = 5 V

(a) 25 V, 15 V   (b) 10 V, 15 V   (c) 15 V, 10 V   (d) 25 V, 5 V

28. A radar has a power of 1 kW and is operating at a frequency of 10 GHz. It is located on a mountain top of height 500 m. The maximum distance up to which it can detect an object located on the surface of the earth is (Radius of earth = $6.4 \times 10^6$ m)
(a) 80 km   (b) 16 km   (c) 40 km   (d) 64 km

29. An AM radio station operating at 530 kHz is permitted to broadcast audio frequencies up to 5 kHz. The band pass filter in its modulation circuit can retain the frequencies
(a) 1060 kHz, 530 kHz
(b) 535 kHz, 530 kHz
(c) 5 kHz, 530 kHz
(d) 10 kHz, 5 kHz

30. Figure shows a communication system. What is the output power when input signal is 1.01 mW?

\[
\text{Gain in dB} = 10 \log_{10} \left( \frac{P_o}{P_i} \right)
\]
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(a) 90 mW  (b) 101 mW
(c) 112 mW  (d) 120 mW

1. (b): The block diagram of a basic communication system is as shown in the figure.

[Diagram of a basic communication system]

Thus, the correct sequence is 24513.

2. (d): Any device that converts one form of energy into another is called a transducer. Loudspeaker, microphone and earphone are transducers but not an amplifier.

3. (c): Let $A_c$ and $A_m$ be the amplitude of carrier wave and message signal respectively. Then

- Maximum amplitude, $A_{\text{max}} = A_c + A_m$ ... (i)
- Minimum amplitude, $A_{\text{min}} = A_c - A_m$ ... (ii)

On solving eqns (i) and (ii), we get

$$A_c = \frac{A_{\text{max}} + A_{\text{min}}}{2} \quad \text{and} \quad A_m = \frac{A_{\text{max}} - A_{\text{min}}}{2}$$

Modulation index, $\mu = \frac{A_m}{A_c} = \frac{A_{\text{max}} - A_{\text{min}}}{A_{\text{max}} + A_{\text{min}}}$

Here, $A_{\text{max}} = 20$ V, $A_{\text{min}} = 4$ V

$$\mu = \frac{20 \text{ V} - 4 \text{ V}}{20 \text{ V} + 4 \text{ V}} = \frac{16 \text{ V}}{24 \text{ V}} = \frac{2}{3}$$

4. (a): Modulation index $\mu \leq 1$ to avoid distortion. The audible range of frequencies is 20 Hz to 20 kHz.

In amplitude modulation, the bandwidth is twice the modulating frequency.

5. (c): AM is used for broadcasting because its use avoids receiver complexity. Only a diode and a capacitor are sufficient to separate the audio signal from the AM wave.

6. (c): The maximum line-of-sight distance $d_M$ between two antennas having heights $h_T$ and $h_R$ is

$$d_M = \sqrt{2Rh_T} + \sqrt{2Rh_R}$$

where $R$ is the radius of the earth, $h_T$ and $h_R$ are the heights of the transmitting and receiving antennas respectively.

Here, $d_M = 40$ km $= 40 \times 10^3$ m, $h_T = 20$ m, $h_R = h$, $R = 6400$ km $= 6400 \times 10^3$ m

$$40 \times 10^3 = \sqrt{2 \times 6400 \times 10^3 \times 20 + \sqrt{2 \times 6400 \times 10^3 \times h}}$$

$$40 \times 10^3 = 16 \times 10^3 + \sqrt{2 \times 64 \times 10^5 \times h}$$

$$h = \frac{[(40 - 16) \times 10^3]^2}{2 \times 64 \times 10^5} = 45 \text{ m}$$

7. (b): A vibrating tuning fork and musical sound due to a vibrating sitar string produce analog signals.

Light pulse and output of a NOR gate produce digital signals.

8. (d): Half duplex device – Walky talky
   Full duplex device – Mobile phone
   Modem – Modulator and demodulator
   Fax – Transmission and reproduction of documents at a distant place

9. (b): Here, $\nu_m = 10$ kHz $= 0.01$ MHz, $A_m = 10$ V, $\nu_c = 1$ MHz, $A_c = 20$ V

Modulation index, $\mu = \frac{A_m}{A_c} = \frac{10}{20} = 0.5$

The side band frequencies are

$$\nu_{SB} = \nu_c \pm \nu_m = (1 \pm 0.01) \text{ MHz}$$

10. (d): Here, $R = 1$ M$\Omega = 10^6$ $\Omega$

$$C = 1 \text{ pF} = 10^{-12} \text{ F}$$

$$RC = (10^6)(10^{-12}) = 10^{-6} \text{ s}$$

For demodulation, $\frac{1}{\nu_c} << RC$ or $\nu_c >> \frac{1}{RC}$

where $\nu_c$ is the frequency of the carrier signal.

$$\nu_c >> \frac{1}{10^6} = 10^6 \text{ Hz} = 1 \text{ MHz}$$

Thus, it would be more suitable for detecting a carrier signal of 10 MHz.

11. (d): The preferred modulation scheme for digital communication is pulse code modulation.
12. (b): Name of service Frequency band
- AM broadcast: 540 - 1600 kHz
- FM broadcast: 88 - 108 MHz
- UHF TV: 420 - 890 MHz
- Downlink of satellite communication: 3.7 - 4.2 GHz

13. (c): The block diagram of a detector for AM signal is as shown in the figure. The box X is a rectifier and the box Y is an envelope detector.

14. (a): In TV broadcasting both AM and FM are used. AM is for video (picture) signal and FM is for audio (sound) signal.

15. (b): Space waves are used for satellite communication.

16. (c): In point-to-point communication mode, communication takes place over a link between a single transmitter and a receiver. Telephony is an example of such a mode of communication.

17. (d): Carrier frequency > Audio frequency

18. (a): Bandwidth is twice the maximum frequency of modulating signal.
- Bandwidth of the channel = 2(\(u_m\))_{\text{max}} = 2 \times 5000 \text{ Hz} = 10000 \text{ Hz} = 10 \text{ kHz}

19. (c): The radiowaves of frequency 3 MHz to 30 MHz are used in sky wave propagation as they are reflected by the ionosphere of earth's atmosphere.

20. (d): Layers of ionosphere
- \(D\) Day only
- \(E\) Day only
- \(F_1\) Daytime, merges with \(F_2\) at night
- \(F_2\) Day and night

21. (b): Here, total bandwidth = 100 kHz
- Any station being modulated by a 5 kHz signal will produce an upper side frequency 5 kHz above its carrier and a lower side frequency 5 kHz below its carrier, thereby requiring a bandwidth of 10 kHz.
- Number of stations accommodated = \(\frac{\text{Total bandwidth}}{\text{Bandwidth per station}}\) = \(\frac{100 \times 10^3 \text{ Hz}}{10 \text{ kHz}}\) = 10

22. (b): For the communication of AM channel of frequency 1020 kHz, ground wave propagation is used. For this the antenna need not be very tall.
- For the communication of FM channel of frequency 89.5 MHz, the space wave propagation is needed. For this, very tall towers are used as antenna.

23. (a): Here, \(u = 300 \text{ MHz} = 300 \times 10^6 \text{ Hz} = 3 \times 10^8 \text{ Hz}\)
- Length of the dipole antenna = \(l = \frac{u^2}{\lambda} = \frac{\left(3 \times 10^8 \text{ Hz}\right)^2}{299.8 \times 10^6 \text{ m/s}}\) = 310 ms

24. (b): Power radiated by the linear antenna is proportional to \(\left(\frac{l}{\lambda}\right)^2\).

25. (b): Maximum distance covered by space wave communication = \(2R_h\) = \(2 \times 26.4 \times 10^3 \text{ km} \times 100 \text{ km} = 2640 \text{ km}\).
- As the distance between transmitter and receiver is 100 km, so propagation via space wave is not possible for the signal of frequency 5 MHz.
- For sky wave propagation, critical frequency, \(u_c = 9(\text{Nmax})^{1/2} = 9(10^{12})^{1/2}\) = 9 MHz
- As signal of frequency 5 MHz is less than \(u_c\), so the propagation of signal of frequency 5 MHz is possible via sky wave.
27. (c) : 
From figure,

\[ V_{\text{max}} = 50 \text{ V} \]
\[ V_{\text{min}} = -25 \text{ V} \]

Peak carrier voltage,
\[ V_c = V_{\text{max}} + V_{\text{min}} = 50 - 25 = 25 \text{ V} \]

Peak information voltage,
\[ V_m = V_{\text{max}} - V_{\text{min}} = 50 - (-25) = 75 \text{ V} \]

28. (a) :
Let \( M \) be the mountain top where a radar has been operating to locate the objects on earth.
Let \( d(MA) = MB \) be the maximum distance of radar from earth where object can be detected.
Refer figure,
\[ d^2 + R^2 = (h + R)^2 = h^2 + 2hR + R^2 \]
or
\[ d^2 = h^2 + 2hR \]

Since \( h \ll R \), so \( h^2 \) can be neglected in comparison to \( 2hR \).
\[ d = \sqrt{2hR} \]

Here, \( h = 500 \text{ m} \), \( R = 6.4 \times 10^6 \text{ m} \)
\[ d = \sqrt{2 \times 500 \times 6.4 \times 10^6} \approx 80 \times 10^3 \text{ m} = 80 \text{ km} \]

29. (b) :
The band pass filter retains the frequencies \( u_c \), \( u_c - u_m \) and \( u_c + u_m \) and rejects the frequencies \( u_m \), \( 2u_m \) and \( 2u_c \).

Here, \( u_c = 530 \text{ kHz} \), \( u_m = 5 \text{ kHz} \)
The frequencies retained by the band pass filter are:
\[ u_c = 530 \text{ kHz} \]
\[ u_c - u_m = (530 - 5) \text{ kHz} = 525 \text{ kHz} \]
\[ u_c + u_m = (530 + 5) \text{ kHz} = 535 \text{ kHz} \]

30. (b) :
Here, transmission path = 5 km
Loss suffered in transmission path = \( -2 \text{ dB km}^{-1} \times 5 \text{ km} = -10 \text{ dB} \)
Total amplifier gain = 10 dB + 20 dB = 30 dB
Overall gain of the signal = 30 dB - 10 dB = 20 dB
As, gain in dB
\[ \frac{P_o}{P_i} = \left( \frac{10}{10} \right)^{20} \log_{10} \frac{P_o}{P_i} \]
or
\[ \log_{10} \frac{P_o}{P_i} = 2 \times 10 = 20 \]
or
\[ P_o = P_i \times 10^2 = 1.01 \text{ mW} \times 100 = 101 \text{ mW} \]

For more detailed solution refer November issue of Physics For You.