MADE EASY PUBLICATIONS

POSTAL BOOK PACKAGE 2024

CONTENTS

ELECTRONICS ENGINEERING

Objective Practice Sets

Advanced Communication

1 CHAPTER Microwave Communication

Q.1 The frequency range of very high frequency (VHF) is
(a) 300 MHz – 3000 MHz
(b) 30 MHz – 300 MHz
(c) 3 MHz – 30 MHz
(d) 30 THz – 3000 Hz

Q.2 One of the reasons why vacuum tubes eventually fail at microwave frequencies is that their
(a) transmit time becomes too short
(b) noise figure increases
(c) shunt capacitive reactance becomes too large
(d) series inductive reactance becomes too small

Q.3 In microwave communication links, when fading due to rain attenuation occurs, the techniques adopted for solving the problem would include
(a) antenna replacement and feed correction
(b) amplitude trimming and phase correction
(c) polarization shifting and code diversity
(d) path diversity and frequency diversity

Q.4 Ionospheric propagation is not possible for microwave because
(a) microwaves will be fully absorbed by the ionospheric layers
(b) there will be an abrupt scattering in all direction
(c) microwaves will penetrate through the ionospheric layers
(d) there will be dispersion of microwave energy

Q.5 The MUF for an angle of incidence of 60° and a critical frequency of 60 MHz will be
(a) 45.0 MHz (b) 111.7 MHz
(c) 120 MHz (d) 150 MHz

Q.6 Calculate the critical frequency of *E*-layer if its average density is 10^{10} per cubic meter?
(a) 6×10^5 Hz (b) 7×10^5 Hz
(c) 8×10^5 Hz (d) 9×10^5 Hz

Q.7 A microwave communication link employs two antennas for transmission and reception elevated at 200 m and 80 m, respectively. Considering obliqueness of the Earth, the maximum possible link distance is
(a) 46 km (b) 64 km
(c) 96 km (d) 102 km

Q.8 Transmission of signals in a terrestrial microwave system is achieved through
(a) reflection from the ionosphere
(b) line-of-sight mode
(c) reflection from the ground
(d) diffraction from the stratosphere

Q.9 In the terrestial paths of a microwave communication system, which technique is usually adopted to overcome signal loss due to earth's curvature?
(a) Link repeaters are arranged with 50 km apart
(b) Link repeaters are arranged with 500 km apart
(c) Signal amplifiers are arranged every 5 km apart
(d) Phase correctors are located every 2 km apart

Q.10 In microwave communication, sometimes microwave signals reach large distances by following the earth's curvature. This phenomenon is called
(a) tropospheric scatter
(b) Faraday effect
(c) ionospheric reflection
(d) ducting

Q.11 During power measurement the out power measured was –90 dBm. What is the measured power in W?
(a) 1 mW (b) 1 pW
(c) 10 W (d) 1 W

Q.12 Two LOS antennas having power gains of G_1 and G_2 are separated by a distance 'L'. λ is the operating wavelength. If P_t is the transmitted power and P_r is the power received, then the ratio P_r/P_t will be proportional to

(a) $G_1G_2\left(\frac{L}{\lambda}\right)^2$ (b) $\frac{G_1}{G_2}\left(\frac{L}{\lambda}\right)^2$

(c) $\frac{G_2}{G_1}\left(\frac{L}{\lambda}\right)^2$ (d) $G_1G_2\left(\frac{\lambda}{L}\right)^2$

Q.13 Free-space propagation path loss is
(a) inversely proportional to frequency of transmission.
(b) directly proportional to frequency of transmission.
(c) directly proportional to distance of transmission.
(d) directly proportional to square of the frequency of transmission.

Q.14 Duct propagation of microwave occurs due to which one of the following?
(a) Variation of refractive index with wavelength
(b) Variation of refractive index with length
(c) Variation of refractive index with height
(d) None of the above

Q.15 Match **List-I** with **List-II** and select the correct answer using the codes given below the lists:

	List-I		List-II
A.	Ground wave	1.	3 - 30 MHz
B.	Space wave	2.	< 3 MHz
C.	Sky wave	3.	> 300 MHz
D.	Troposcatter wave	4.	30 - 300 MHz

Codes:

	A	B	C	D
(a)	1	2	3	4
(b)	3	4	2	1
(c)	4	3	2	1
(d)	2	4	1	3

Q.16 Maximum frequency reflected from an ionospheric layer is 9 MHz. The maximum ion density of that layer is
(a) 10^8 m^{-3} (b) 10^6 m^{-3}
(c) 10^{12} m^{-3} (d) 10^9 m^{-3}

Q.17 Consider the following statements about the maximum usable frequency (MUF) for radio communication between two specified points using an ionospheric layer
1. MUF is equal to critical frequency
2. MUF is more than the critical frequency
3. MUF depends upon the height of the ionospheric layer
4. MUF depends upon the distance between the two points

Which of these statements are correct?
(a) 1, 2, 3 and 4 (b) 2 and 3 only
(c) 3 and 4 only (d) 2 and 4 only

Q.18 Consider the following statements regarding a microwave link:
1. Fade margin (sometimes called link margin) is essentially included in system gain equation that considers the non-ideal and less predictable characteristics.
2. The system gain depends on the gain of both transmitter and receiver antennas.

Which of the above statements is/are correct?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q.19 What should be the frequencies used for communication inside the coal mines, from the viewpoint of minimizing the propagation path loss?
(a) In the range from 30 MHz to 400 MHz
(b) In the range from 1 GHz to 4 GHz
(c) In the range from 500 MHz to 1 GHz
(d) In the range from 1 GHz to 2 GHz

Q.20 A microwave transmitting antenna is placed at a height of 100 m and the receiving antenna is placed at ground level. It is intended to increase the line-of-sight distance between transmitter and receiver by 20% from the existing value. Then to achieve this, the transmitting antenna should be placed at a height of
(a) 112 m (b) 120 m
(c) 144 m (d) 164 m

Q.21 The free-space path loss at a distance of 16 km from a microwave antenna operating at 2 GHz is approximately equal to
(a) 167.5 dB (b) 122.5 dB
(c) 90 dB (d) 77.5 dB

Q.22 Consider the following statements about microwave communication:
1. Minimum delay time is introduced in communication.
2. Transit time is more critical at microwave frequencies.

3. It is more easy to analyse and design circuits at microwave frequencies.

Which of the above statements is/are **incorrect**?

(a) 1 only (b) 2 and 3 only
(c) 3 only (d) 1 and 2 only

Q.23 **Statement (I):** Space wave is used for propagation of FM broadcast system.

Statement (II): Several independent interference free transmitters can be operated on the same frequency because of line-of-sight propagation.

(a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I).
(b) Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I).
(c) Statement (I) is true but Statement (II) is false.
(d) Statement (I) is false but Statement (II) is true.

■■■■

Answers Microwave Communication

1. (b)	2. (a)	3. (d)	4. (c)	5. (c)	6. (d)	7. (c)	8. (b)	9. (a)
10. (d)	11. (b)	12. (d)	13. (d)	14. (c)	15. (d)	16. (c)	17. (d)	18. (c)
19. (a)	20. (c)	21. (b)	22. (c)	23. (a)				

Explanations Microwave Communication

1. (b)

Frequency range:

VLF = 3 – 30 kHz
LF = 30 – 300 kHz
MF = 0.3 – 3 MHz
HF = 3 – 30 MHz
VHF = 30 – 300 MHz
UHF = 300 – 3 GHz
SHF = 3 – 30 GHz
EHF = 30 – 300 GHz

2. (a)

Transit time is the time taken by electrons to travel from cathode to anode. At microwave frequencies, the transit time becomes comparable to the time period and hence, the vacuum tubes fail at microwave frequencies.

3. (d)

Diversity techniques are used to improve the performance of a fading radio channel, wherein multiple copies of the same information is transmitted to the receiver on statistically independent paths/channels. To overcome fading due to rain attenuation, path diversity and frequency diversity can be used wherein multiple copies of the signal are transmitted over different paths and frequencies respectively.

4. (c)

Microwave frequencies penetrate through the ionosphere and are not reflected back. In general, frequencies above 30 MHz will penetrate through ionosphere.

5. (c)

$$f_{MUF} = f_c \sec\theta_i = \frac{f_c}{\cos\theta_i}$$

$$f_{MUF} = \frac{60}{0.5} = 120 \text{ MHz}$$

6. (d)

Critical frequency,

$$f_c = \sqrt{81 \times N_{max}}$$

$$= \sqrt{81 \times 10^{10}} = 9 \times 10^5 \text{Hz}$$

7. (c)

$$h_t = 200 \text{ m}$$
$$h_r = 80 \text{ m}$$
$$d = 4.12\left[\sqrt{h_t} + \sqrt{h_r}\right] \text{km}$$
$$= 4.12\left[\sqrt{200} + \sqrt{80}\right] \text{km}$$
$$= 95.11 \text{ km} \simeq 96 \text{ km}$$

8. (b)

Terrestrial microwave system use line-of-sight transmission and signals travel in straight line.

9. (a)

Microwave signals propagate along the line of sight. Therefore, the Earth's curvature limits the range over which a microwave communication link can be established. A transmitting antenna sitting on a 25 ft high tower can typically communicate only up to a distance of about 50 km. Repeaters can be placed at regular intervals to extend the range, which receives and retransmits the signal.

10. (d)

At VHF, UHF and microwaves, the waves are neither reflected by ionosphere nor propagated along the earth's surface but the transmission occurs beyond the line of sight distance due to refraction of such high frequency waves in the troposphere. Due to turbulence in air, different layers of air have different temperature and vapour contents which leads to formation of the air forming a duct or a sort of leaky waveguide which guides the electromagnetic wave between the walls.

11. (b)

$$-90 \text{ dBm} = 10 \log \frac{P(\text{Watts})}{1 \times 10^{-3}}$$

$$\frac{P(\text{watts})}{10^{-3}} = 10^{-9}$$

$$P = 10^{-12} \text{ watts} = 1 \text{ pW}$$

12. (d)

As per the FRIIS equation,

$$P_r = \frac{P_t \cdot G_t \cdot G_r}{\left(\frac{4\pi d}{\lambda}\right)^2}$$

G_t = Gain of transmitting antenna
G_r = Gain of receiving antenna
P_t = Transmitted power
d = Distance between antennas

$$P_r = P_t G_1 G_2 \left(\frac{\lambda}{4\pi L}\right)^2$$

$$\therefore \quad \frac{P_r}{P_t} \propto G_1 G_2 \left(\frac{\lambda}{L}\right)^2$$

13. (d)

$$(\text{FSL}) = \left(\frac{4\pi d}{\lambda}\right)^2 = \left(\frac{4\pi d f}{c}\right)^2$$

14. (c)

Duct propagation occurs due to variation of refractive index with height and the wave propagates because of refraction.

15. (d)

Ground-wave : Attenuation of earth increases as the frequency increases and hence, the mode of propagation is suitable for low and medium frequency, i.e., upto 3 MHz only.

Sky-wave : Frequencies above 30 MHz penetrate through ionosphere and hence, sky-wave propagation not possible beyond 30 MHz.

Space-wave : Space-wave is mainly used for frequencies above 30 MHz, i.e., VHF. At such frequency, sky wave and ground wave propagation fails.

Tropospheric scatter propagation: It is used for VHF and microwaves, i.e., above 300 MHz.

16. (c)

$$f = 9\sqrt{N_{max}}$$

$$9 \times 10^6 = 9 \times \sqrt{N_{max}}$$

$$N_{max} = (10^6)^2 \text{ m}^{-3} = 10^{12} \text{ m}^{-3}$$

17. (d)

$$\text{MUF} = f_c \sec\phi$$

where, f_c = critical frequency
ϕ = incidence angle

So MUF > f_c

Also angle of incidence is governed by the distance between the two points.

18. (c)

Fade margin is taken as the safety margin to compensate against path fading that weakens the radio signals. Fade margin is the insurance against unexpected system outrages.

Also,

$P_r(dB) = P_t(dB) + G_t(dB) + G_r(dB) - P_L(dB)$

$P_r(dB) - P_t(dB) = G_t(dB) + G_r(dB) - P_L(dB)$

Hence, the system gain depends on the gain of both transmitter and receiver antennas.

19. (a)

$$\text{Path loss} = \left(\frac{4\pi d}{\lambda}\right)^2 = \left(\frac{4\pi d}{c}\right)^2 \cdot f^2$$