

ECH501 - COMMUNICATION SYSTEMS

QUESTION BANK

UNIT I: TRANSMISSION LINES, WAVE PROPAGATION, ANTENNA

PART - A

1. MCQs (21)

1. Which part of the EM spectrum is typically used for FM radio broadcasting?

- A) 3-30 kHz B) 88-108 MHz C) 300-3000 GHz D) 1-2 GHz (only)

Answer: B

2. Characteristic impedance of a transmission line is defined as:

- A) Ratio of voltage to current at the load end B) Ratio of voltage to current for a wave travelling in one direction on an infinite line C) Resistance of the line per unit length D) Reactance offered by the line

Answer: B

3. Which of the following is a type of transmission line?

- A) Coaxial cable B) Twisted pair C) Waveguide D) All of the above

Answer: D

4. Ground wave propagation is significant mainly for which frequency range?

- A) VHF B) UHF C) LF and MF D) Microwave

Answer: C

5. Sky wave propagation depends mainly on which atmospheric layer?

- A) Troposphere B) Ionosphere C) Stratosphere D) Exosphere

Answer: B

6. Space wave propagation is mainly used in:

- A) AM broadcasting B) Line-of-sight VHF/UHF/microwave communication C) Ground wave communication only D) Sky wave communication only

Answer: B

7. An antenna is a device used to:

- A) Store electrical energy B) Convert electrical energy into EM waves and vice versa C) Amplify signals D) Filter noise

Answer: B

8. The radiation pattern of an antenna represents:

- A) Variation of impedance with frequency B) Variation of radiated power with direction C) Variation of gain with time D) Variation of voltage with current

Answer: B

9. Bandwidth of an antenna refers to:

- A) Range of frequencies over which it operates satisfactorily B) Physical size of the antenna C) Number of elements in an array D) Polarization angle

Answer: A

10. Beamwidth of an antenna is measured between:

- A) Two half-power points of the main lobe B) First and second side lobes C) Null points only D) Feed point and radiating element

Answer: A

11. Directivity of an antenna is a measure of:

- A) Power loss in the antenna B) Ability to concentrate radiated power in a particular direction C) Bandwidth of operation D) Physical gain in decibels only

Answer: B

12. A microstrip patch antenna is fabricated using:

- A) Waveguide technology B) Printed circuit board technology C) Fiber optic cable D) Coaxial cable only

Answer: B

13. Horn antennas are commonly used at:

- A) Audio frequencies B) Microwave frequencies C) Power line frequencies D) DC

Answer: B

14. Which frequency range corresponds to microwaves in the EM spectrum?

- A) 3 Hz - 3 kHz B) 300 MHz - 300 GHz C) 3 kHz - 30 kHz D) 30 Hz - 300 Hz

Answer: B

15. Ionospheric reflection enables communication over:

- A) Very short distances only B) Long distances beyond line of sight C) Only within a building D) Underwater only

Answer: B

16. A transmission line terminated with load impedance equal to its characteristic impedance results in:

- A) Maximum reflection B) No reflection (maximum power transfer) C) Infinite standing wave ratio D) Complete signal loss

Answer: B

17. Which of the following is NOT a commonly named type of transmission line?

- A) Parallel wire line B) Coaxial line C) Microstrip line D) Photonic crystal fiber

Answer: D

18. Parameters used to characterize an antenna include:

A) Gain, directivity, bandwidth, beamwidth B) Only weight C) Only cost D) Only color

Answer: A

19. Which propagation mechanism is most affected by the Earth's curvature at higher frequencies?

A) Ground wave B) Sky wave C) Space wave D) None of the above

Answer: C

20. The electromagnetic spectrum arranges waves based primarily on:

A) Amplitude B) Frequency/wavelength C) Phase D) Polarization only

Answer: B

21. A microstrip patch antenna is generally preferred in mobile devices because it is:

A) Bulky and heavy B) Low profile, light weight, and easy to fabricate C) Used only for radar D) Used only at audio frequencies

Answer: B

2. Analytical MCQs (9)

22. If the characteristic impedance of a lossless transmission line is $Z_0 = \sqrt{L/C}$, doubling the inductance per unit length L (keeping C constant) will:

A) Decrease Z_0 by a factor of $\sqrt{2}$ B) Increase Z_0 by a factor of $\sqrt{2}$ C) Keep Z_0 unchanged D) Double Z_0

Answer: B

23. AM radio stations are heard over much longer distances at night than during the day. This is best explained by:

A) Increased ground wave attenuation at night B) Disappearance of the ionospheric D-layer at night, allowing greater sky wave range C) Reduced antenna efficiency during the day D) Space wave dominance at night

Answer: B

24. An antenna has a half power beamwidth (HPBW) of 20 degrees, compared to another with HPBW of 60 degrees. The narrower-beamwidth antenna generally has:

A) Lower directivity B) Higher directivity C) Same directivity D) No relation to directivity

Answer: B

25. Two antennas share the same physical aperture, but Antenna X has higher radiation efficiency than Antenna Y. For equal input power, Antenna X will have:

A) Lower gain than Y B) Higher gain than Y C) Equal gain to Y D) Undefined relationship

Answer: B

26. A transmission line is terminated in a load exactly equal to its characteristic impedance. The voltage standing wave ratio (VSWR) on this line will be:

A) Infinite B) Zero C) 1 D) Greater than 1 but finite

Answer: C

27. For long-distance HF communication such as international shortwave broadcasting without satellites, engineers primarily rely on:

A) Ground wave propagation B) Sky wave propagation via ionospheric refraction
C) Space wave propagation D) Direct wired link

Answer: B

28. A horn antenna is often chosen over a simple dipole as a waveguide feed primarily because it provides:

A) Lower directivity and larger beamwidth B) Better impedance matching and higher gain
C) Only mechanical strength D) Reduced bandwidth

Answer: B

29. If the operating frequency of a communication link is increased from HF to microwave, the propagation mode principally used shifts from sky wave to:

A) Ground wave B) Space wave (line-of-sight) C) Sky wave (remains the same)
D) No propagation is possible

Answer: B

30. Two identical microstrip patch antennas differ only in substrate dielectric constant; Antenna A uses a higher dielectric constant than Antenna B. For the same operating frequency, Antenna A will generally have:

A) Larger physical size than B B) Smaller physical size than B C) The same size as B
D) A size that cannot be determined

Answer: B

PART - B

1. Descriptive Questions (4)

1. Explain the electromagnetic frequency spectrum with its major frequency bands and typical applications of each band.
2. Define the characteristic impedance of a transmission line and briefly describe the different types of transmission lines used in communication systems.
3. Describe ground wave, sky wave, and space wave propagation mechanisms, highlighting the frequency ranges and typical applications of each.
4. Explain the important parameters of an antenna such as radiation pattern, bandwidth, beamwidth, and directivity, and briefly describe the working of microstrip patch and horn antennas.

2. Analytical Descriptive Question (1)

5. A communication engineer needs to design a link that must work reliably both during the day and at night over a distance of 2000 km without using satellites. Analyze which propagation mechanism(s) should be used, explaining how the choice of frequency

band affects the reliability of the link, and justify your answer using the concepts of ground wave, sky wave, and space wave propagation.

UNIT II: CELLULAR COMMUNICATION

PART - A

1. MCQs (21)

1. The cellular concept primarily helps in:

A) Increasing transmitter power indefinitely B) Efficient reuse of frequency spectrum over a geographic area C) Eliminating the need for base stations D) Avoiding handoff

Answer: B

2. GSM primarily uses which multiple access technique?

A) CDMA only B) A combination of TDMA and FDMA C) OFDMA only D) SDMA only

Answer: B

3. Compared to 3G, 4G LTE offers:

A) Lower data rates B) Higher data rates with an all-IP packet-switched architecture
C) Only circuit switching D) No improvement in latency

Answer: B

4. 5G NR compared to 4G LTE primarily offers:

A) Lower bandwidth B) Higher data rates, lower latency, and massive device connectivity
C) Only voice services D) The same data rate as 4G

Answer: B

5. The GSM system block diagram includes which major subsystems?

A) Mobile Station, Base Station Subsystem, Network Switching Subsystem B) Only the mobile station
C) Only the base station D) Only the antenna

Answer: A

6. Handoff (handover) in cellular systems refers to:

A) Switching off the mobile phone B) Transferring an ongoing call from one cell/base station to another
C) Increasing transmitter power D) Blocking a call

Answer: B

7. Hard handoff is characterized by:

A) Simultaneous connection to two base stations B) A break-before-make connection switch
C) No connection change D) Continuous connection to the same cell only

Answer: B

8. Soft handoff is typically associated with:

A) TDMA systems only B) CDMA systems, using a make-before-break approach
C) FDMA systems only D) GSM only

Answer: B

9. Cell splitting is done to:

A) Reduce network capacity B) Increase system capacity by subdividing congested cells into smaller cells C) Eliminate the need for base stations D) Increase cell size

Answer: B

10. Sectoring a cell using directional antennas helps to:

A) Increase co-channel interference B) Reduce co-channel interference and improve capacity C) Eliminate frequency reuse D) Decrease the number of channels

Answer: B

11. The Base Transceiver Station (BTS) in GSM is responsible for:

A) Billing customers B) Radio transmission and reception with mobile stations C) Long distance switching D) Internet routing

Answer: B

12. The Mobile Switching Center (MSC) in GSM performs:

A) Radio signal processing only B) Call switching and mobility management C) Only SIM card storage D) Antenna radiation pattern control

Answer: B

13. Which generation of cellular standard first introduced a fully packet-switched, all-IP architecture?

A) 2G B) 3G C) 4G LTE D) 1G

Answer: C

14. 5G NR is designed to primarily support which use case categories?

A) eMBB, URLLC, mMTC B) Only voice calls C) Only SMS D) Only 2G legacy support

Answer: A

15. When compared based on data rate, 5G offers data rates that are:

A) Lower than 2G B) Comparable to 2G C) Significantly higher, up to multi-Gbps
D) Only equal to 4G

Answer: C

16. In cellular systems, frequency reuse refers to:

A) Using the same frequency channels in different cells separated by sufficient distance B) Never reusing frequencies C) Using only one frequency for the whole network D) Reusing a frequency within the same cell simultaneously

Answer: A

17. Improving capacity in a congested urban cellular network is commonly achieved by:

A) Increasing cell size B) Cell splitting and sectoring C) Removing base stations
D) Reducing the number of channels

Answer: B

18. The Home Location Register (HLR) in a GSM network stores:

A) Call charging hardware B) Subscriber information for the home network C)
Base station coordinates only D) Antenna radiation data

Answer: B

19. LTE stands for:

A) Long Term Evolution B) Line Transfer Equipment C) Low Traffic Exchange D)
Local Transmission Efficiency

Answer: A

20. NR in 5G NR stands for:

A) New Radio B) Network Router C) Node Relay D) Network Range

Answer: A

21. Which handoff mechanism minimizes the chance of a dropped call by connecting to the new base station before disconnecting from the old one?

A) Hard handoff B) Soft handoff C) No handoff D) Manual handoff

Answer: B

2. Analytical MCQs (9)

22. A cellular operator observes high call drop rates at cell boundaries in a CDMA network. Which handoff strategy would best reduce this problem?

A) Hard handoff B) Soft handoff C) No handoff D) Disabling handoff

Answer: B

23. An urban cell is experiencing congestion due to high user density. Without acquiring new spectrum, the most effective solution is:

A) Increasing the cell radius B) Performing cell splitting to create smaller cells C)
Removing sectoring D) Turning off some base stations

Answer: B

24. If a network reduces the reuse distance between cells using the same frequency, this will most likely:

A) Decrease co-channel interference B) Increase co-channel interference C) Have
no effect on interference D) Only affect handoff

Answer: B

25. For a use case requiring extremely low latency and high reliability (e.g., autonomous vehicles), which 5G service category is most relevant?

A) eMBB B) URLLC C) mMTC D) None of the above

Answer: B

26. A network designer introduces three 120-degree directional antennas per cell site to increase capacity without splitting the cell. This works mainly by:

A) Increasing transmitted power indefinitely B) Reducing co-channel interference through sectoring, allowing tighter frequency reuse C) Doubling the bandwidth automatically D) Eliminating the need for handoff

Answer: B

27. During a hard handoff, if the connection to the new base station fails momentarily before the old one is dropped, the likely consequence is:

A) No effect on the call B) A brief call interruption or drop C) An automatic upgrade to 5G D) Permanent connection improvement

Answer: B

28. A mobile device moving at high speed between small 5G mmWave cells will require:

A) No handoff at all B) Frequent and fast handoff mechanisms C) Only sky wave propagation D) Only satellite-based handoff

Answer: B

29. GSM (2G), being primarily designed for voice and low-rate data, would be least suitable for supporting:

A) Voice calls B) SMS C) High-definition video streaming D) Basic text messaging

Answer: C

30. In a massive machine type communication (mMTC) scenario with millions of IoT devices per square kilometer, the primary 5G design priority is:

A) Extremely high per-device data rate B) High connection density with low power consumption C) High voice quality only D) High video calling quality only

Answer: B

PART - B

1. Descriptive Questions (4)

1. Explain the cellular concept and describe the block diagram of the GSM system with its major subsystems.

2. Compare various cellular communication standards (2G, 3G, 4G LTE, 5G NR) based on their data rates and key features.

3. Explain different handoff mechanisms used in cellular systems, distinguishing between hard handoff and soft handoff with suitable examples.

4. Discuss the techniques of cell splitting and sectoring used to improve coverage and capacity in cellular systems.

2. Analytical Descriptive Question (1)

5. A city's cellular network faces severe congestion during peak hours in its central business district, leading to blocked calls and poor data speeds, while suburban areas

have underutilized capacity. Analyze how cell splitting, sectoring, and modern 4G/5G techniques could be combined to solve the congestion problem, and justify a strategy that balances coverage and capacity requirements.

UNIT III: SATELLITE COMMUNICATION

PART - A

1. MCQs (21)

1. Which frequency is commonly allocated for satellite communication uplink in the C-band?

- A) 4 GHz B) 6 GHz C) 20 GHz D) 30 GHz

Answer: B

2. LEO stands for:

- A) Low Earth Orbit B) Long Earth Orbit C) Line Earth Orbit D) Low Energy Orbit

Answer: A

3. MEO satellites typically orbit at an altitude range of about:

- A) 200-500 km B) 2,000-20,000 km C) 35,786 km D) Beyond 100,000 km

Answer: B

4. A geostationary orbit is located at an altitude of approximately:

- A) 500 km B) 2,000 km C) 35,786 km D) 100,000 km

Answer: C

5. A satellite in geostationary orbit appears to an observer on Earth as:

- A) Moving rapidly across the sky B) Fixed at one point in the sky C) Moving randomly D) Visible only at night

Answer: B

6. A geosynchronous orbit differs from a geostationary orbit mainly in:

- A) Orbital period B) Possible orbital inclination (geostationary is strictly equatorial)
C) Altitude only D) There is no difference between them

Answer: B

7. Uplink frequency in a satellite link refers to the frequency:

- A) From satellite to earth station B) From earth station to satellite C) Between two satellites D) Used only for TT&C

Answer: B

8. Downlink frequency in a satellite link refers to the frequency:

- A) From earth station to satellite B) From satellite to earth station C) Used only for uplink D) None of the above

Answer: B

9. The TT&C subsystem in a satellite stands for:

A) Telemetry, Tracking, and Command B) Transmission, Testing, and Control C) Transponder, Tracking, and Communication D) Timing, Tracking, and Calibration

Answer: A

10. A transponder in a satellite is primarily responsible for:

A) Generating solar power B) Receiving, amplifying, and retransmitting signals C) Station keeping D) Attitude control only

Answer: B

11. Station keeping in a satellite refers to:

A) Maintaining the satellite's assigned orbital position B) Charging its batteries C) Ground station maintenance D) Transponder repair

Answer: A

12. Attitude control of a satellite ensures:

A) Correct orientation of the satellite in space B) Power generation only C) Frequency allocation only D) Communication with the ground only

Answer: A

13. The power supply subsystem of a satellite typically relies on:

A) Diesel generators B) Solar panels and batteries C) Nuclear reactors, always D) A wired connection from Earth

Answer: B

14. Direct-To-Home (DTH) services primarily use which type of satellite link?

A) Uplink only B) Downlink broadcast to individual homes via satellite C) Terrestrial cable only D) Optical fiber only

Answer: B

15. GPS (Global Positioning System) relies on signals from:

A) A single satellite B) A constellation of MEO satellites C) Only geostationary satellites D) Only ground stations

Answer: B

16. An earth station in satellite communication mainly consists of:

A) Antenna, transmitter, receiver, and associated equipment B) Only an antenna C) Only a power supply D) Only a modem

Answer: A

17. Ku-band frequencies are commonly used for:

A) AM radio broadcasting B) Satellite TV and DTH services C) Ground wave propagation D) Optical communication

Answer: B

18. The main advantage of geostationary satellites for broadcasting is that:

A) They require constant tracking by ground antennas B) Their fixed position simplifies ground antenna pointing C) They orbit very close to Earth D) They have no power requirements

Answer: B

19. LEO satellites are preferred for applications requiring:

A) High latency communication B) Low latency, often used in constellations C) A fixed position in the sky D) Television broadcast only

Answer: B

20. Applications of satellite communication include:

A) Television broadcasting, navigation, weather monitoring, and telecommunication
B) Only military use C) Only radar D) Only optical fiber links

Answer: A

21. The space segment of a satellite communication system includes:

A) Ground antennas only B) The satellite itself with its subsystems (power, TT&C, transponders, antennas) C) Only the earth station D) Only the user terminal

Answer: B

2. Analytical MCQs (9)

22. A satellite must provide continuous coverage of a fixed geographic region for broadcasting without requiring tracking antennas at ground stations. The most suitable orbit choice is:

A) LEO B) MEO C) Geostationary orbit D) Highly elliptical orbit

Answer: C

23. For a navigation system requiring global coverage with multiple satellites visible simultaneously and moderate latency (as in GPS), the preferred orbit type is:

A) LEO B) MEO C) GEO D) Polar orbit only

Answer: B

24. Comparing LEO and GEO satellites for real-time voice communication, LEO offers an advantage in terms of:

A) Higher latency B) Lower signal delay due to closer altitude C) A fixed position over one location D) No need for a satellite constellation

Answer: B

25. A satellite system uses a higher uplink frequency than downlink frequency. This design choice generally helps to:

A) Reduce atmospheric absorption at uplink B) Minimize uplink/downlink interference, exploiting the stronger transmit power available at earth stations C) Eliminate the need for transponders D) Avoid the need for TT&C

Answer: B

26. A satellite experiences gradual orbital drift due to gravitational perturbations. This is corrected by:

- A) The attitude control subsystem only
- B) Station keeping using onboard thrusters
- C) Increasing the solar panel size
- D) Changing the transponder frequency

Answer: B

27. A DTH service provider wants a satellite that stays fixed relative to a rooftop dish without a tracking motor. The satellite should be placed in:

- A) LEO
- B) MEO
- C) Geostationary orbit
- D) Sun-synchronous orbit

Answer: C

28. GPS receivers calculate position by measuring signal travel time from multiple satellites. This technique fundamentally relies on satellites being in:

- A) A single fixed geostationary position
- B) A constellation providing multiple simultaneous line-of-sight satellites (MEO)
- C) Only one satellite in view
- D) Ground-based transmitters only

Answer: B

29. A transponder's function of amplifying a weak uplinked signal before retransmission is critical mainly because:

- A) The uplinked signal is inherently strong and needs no amplification
- B) Signal power is greatly attenuated over the long uplink path and must be restored for a usable downlink
- C) Transponders are only used for power generation
- D) TT&C replaces the transponder's function

Answer: B

30. A designer must choose between GEO and LEO for a satellite internet constellation targeting minimal latency for interactive applications. The best choice is:

- A) GEO, due to fixed coverage
- B) LEO, due to shorter signal path and lower delay
- C) MEO, for reasons not relevant here
- D) Any orbit gives identical latency

Answer: B

PART - B

1. Descriptive Questions (4)

1. Explain the frequency allocation for satellite services and describe the various orbit types (LEO, MEO, GEO) with their characteristics.
2. Draw and explain the block diagram of a satellite communication system, describing the space segment subsystems.
3. Explain the block diagram of an earth station and describe the applications of satellite communication.
4. Describe the concept of Direct-To-Home (DTH) services and explain the basic concept of the Global Positioning System (GPS).

2. Analytical Descriptive Question (1)

5. A telecommunication company wants to design a satellite-based network for real-time global internet connectivity with minimal latency, while another company wants to provide fixed-position television broadcasting to a specific country. Analyze and justify which orbit type (LEO, MEO, or GEO) is most suitable for each application, considering coverage, latency, and ground antenna requirements.

UNIT IV: OPTICAL COMMUNICATION

PART - A

1. MCQs (21)

1. The basic principle of light transmission in an optical fiber is based on:

- A) Diffraction B) Total internal reflection C) Polarization D) Interference

Answer: B

2. Numerical aperture of an optical fiber is a measure of:

- A) The fiber's light-gathering capacity B) The fiber's physical length C) The fiber's cost D) The fiber's color

Answer: A

3. Acceptance angle of an optical fiber is defined as:

- A) The angle at which the fiber breaks B) The maximum angle of incidence at which light can enter the fiber and undergo total internal reflection C) The angle of the fiber core cross-section D) The angle between transmitter and receiver

Answer: B

4. Compared to multimode fibers, single mode fibers have:

- A) A larger core diameter B) A smaller core diameter, allowing only one mode of propagation C) No core at all D) Higher attenuation, always

Answer: B

5. A step index fiber has a refractive index profile that:

- A) Changes gradually from center to cladding B) Remains constant in the core and drops abruptly at the core-cladding boundary C) Is highest at the cladding D) Has no defined profile

Answer: B

6. A graded index fiber has a refractive index profile that:

- A) Remains constant throughout B) Decreases gradually from the center of the core to the cladding C) Increases from core to cladding D) Has no core

Answer: B

7. LED as an optical source is typically used for:

- A) Long-haul, high-speed links only B) Short distance, low-cost, low-to-moderate speed links C) Only microwave links D) Radar applications

Answer: B

8. Compared to LEDs, laser diodes provide:

- A) Lower coherence and higher spectral width B) Higher coherence, narrower spectral width, and higher output power C) No output power D) Only visible light

Answer: B

9. A PIN photodiode is used as:

- A) An optical source B) An optical detector C) A connector D) A coupler

Answer: B

10. APD stands for:

- A) Avalanche Photodiode B) Amplitude Phase Detector C) Analog Photo Device
D) Average Power Diode

Answer: A

11. Compared to PIN photodiodes, APDs provide:

- A) Lower internal gain B) Internal gain due to avalanche multiplication, giving higher sensitivity C) No sensitivity D) Function only as sources

Answer: B

12. Fiber optic connectors are used to:

- A) Permanently join two fiber ends B) Provide a demountable joint between fiber ends or between a fiber and equipment C) Amplify optical signals D) Generate light

Answer: B

13. Fiber optic splices are used for:

- A) Permanent or semi-permanent joining of two fiber ends B) Temporary disconnection C) Light generation D) Signal amplification

Answer: A

14. Optical couplers are primarily used to:

- A) Split or combine optical signals among multiple fiber paths B) Generate laser light
C) Detect light only D) Increase fiber core size

Answer: A

15. A major advantage of optical communication over conventional copper-based communication is:

- A) Higher attenuation B) Lower bandwidth C) Immunity to electromagnetic interference and higher bandwidth D) Higher weight and cost

Answer: C

16. Attenuation in optical fibers can occur due to types of losses such as:

- A) Absorption and scattering losses B) Only magnetic losses C) Only losses due to gravity D) No losses occur in a fiber

Answer: A

17. The core of an optical fiber has a refractive index that is:

- A) Lower than the cladding B) Higher than the cladding, enabling total internal reflection C) Equal to the cladding D) Irrelevant to light propagation

Answer: B

18. A block diagram of a basic optical communication system includes:

- A) Transmitter (source), optical fiber (channel), and receiver (detector) B) Only an antenna and modem C) Only microwave components D) Only a transponder

Answer: A

19. Multimode fibers, due to their larger core, generally suffer from:

- A) No signal distortion B) Modal dispersion, which limits the bandwidth-distance product C) Zero attenuation D) Higher coherence than a laser

Answer: B

20. Ray theory is used to explain light propagation in fibers primarily for:

- A) Single mode fibers with a very small core B) Multimode fibers with a core diameter much larger than the wavelength C) Laser sources only D) Vacuum propagation only

Answer: B

21. In optical communication, the term 'acceptance cone' relates to:

- A) The mechanical shape of the connector B) The cone of angles within which light rays are accepted and guided in the fiber C) The color of the fiber D) The type of laser used

Answer: B

2. Analytical MCQs (9)

22. Fiber A has core index $n_1=1.50$ and cladding index $n_2=1.45$; Fiber B has $n_1=1.50$ and $n_2=1.48$. Compared to Fiber B, Fiber A (larger index difference) will have:

- A) Lower numerical aperture B) Higher numerical aperture C) The same numerical aperture D) No relation to numerical aperture

Answer: B

23. For long-haul, high-bandwidth telecommunication links spanning hundreds of kilometers, the preferred fiber type is:

- A) Multimode step index fiber B) Single mode fiber, due to minimal modal dispersion C) Plastic optical fiber D) None of the above

Answer: B

24. For a low-cost, short-distance optical link (e.g., within a building) that can tolerate some dispersion, the most economical source-fiber combination is:

- A) Laser diode with single mode fiber B) LED with multimode fiber C) APD used as a source D) PIN diode used as a transmitter

Answer: B

25. In a high-sensitivity, long-distance optical receiver application where a weak optical signal must be detected, the preferred photodetector is generally:

- A) A PIN photodiode B) An APD, due to its internal avalanche gain C) An LED D) A laser diode

Answer: B

26. If the acceptance angle of a fiber is increased, all else remaining equal, the numerical aperture will:

- A) Decrease B) Increase C) Remain the same D) Become negative

Answer: B

27. A graded index fiber reduces modal dispersion compared to a step index multimode fiber mainly because:

- A) All rays travel the exact same physical path length B) Rays travelling longer paths near the edge pass through lower refractive index regions and travel faster, equalizing arrival times C) It uses a different type of light source D) It has no core-cladding boundary

Answer: B

28. Using a laser source rather than an LED is advantageous in a wavelength-division multiplexed (WDM) system mainly because of the laser's:

- A) Wide spectral width causing channel overlap B) Narrow spectral width, which minimizes channel crosstalk C) Low output power D) Lack of coherence

Answer: B

29. An optical link experiences high loss attributed to impurities scattering light within the fiber. This loss is best classified as:

- A) Bending loss B) Scattering loss (e.g., Rayleigh scattering) C) Connector loss only D) Fresnel reflection only

Answer: B

30. Two optical fibers need to be joined permanently in a submarine cable with minimal loss and no future need for disconnection. The appropriate joining method is:

- A) A connector B) A splice C) A coupler D) A free space link

Answer: B

PART - B

1. Descriptive Questions (4)

1. Draw and explain the block diagram of an optical communication system, and describe the principle of light transmission in a fiber using ray theory.

2. Define numerical aperture and acceptance angle of an optical fiber, and explain their significance in fiber optic communication.

3. Compare single mode, multimode, step index, and graded index fibers, and briefly explain the advantages of optical communication.

4. Explain the working principle of LED and Laser as optical sources, and PIN and APD as optical detectors.

2. Analytical Descriptive Question (1)

5. A telecom company needs to lay an optical fiber link between two cities located 300 km apart for high-speed internet backbone traffic, while another requirement is a low-

cost, short-range optical link (about 2 km) within a campus network. Analyze and justify the choice of fiber type (single mode/multimode, step/graded index) and the type of optical source and detector suitable for each scenario.

UNIT V: MICROWAVE COMMUNICATION AND RADAR

PART - A

1. MCQs (21)

1. A waveguide Tee is used in microwave systems to:

- A) Amplify microwave signals B) Split or combine microwave power between different ports C) Generate microwave signals D) Detect microwave signals

Answer: B

2. A directional coupler in microwave systems is used to:

- A) Sample a portion of power flowing in one direction with minimal pickup from the reverse direction B) Reflect all power back to the source C) Generate DC power D) Convert microwave signals to optical signals

Answer: A

3. A two-cavity klystron is primarily used as a:

- A) Microwave amplifier/oscillator using velocity modulation of an electron beam B) Optical detector C) Antenna D) Transmission line

Answer: A

4. A magnetron is a microwave device that generates power using:

- A) Velocity modulation only B) Interaction of electrons with crossed electric and magnetic fields in resonant cavities C) Optical amplification D) The piezoelectric effect

Answer: B

5. Magnetrons are commonly used in applications such as:

- A) Microwave ovens and radar transmitters B) Optical fiber communication C) AM radio receivers D) GPS receivers only

Answer: A

6. RADAR stands for:

- A) Radio Detection and Ranging B) Rapid Detection and Recording C) Radio Direction and Range D) Random Detection and Ranging

Answer: A

7. The basic working principle of RADAR involves:

- A) Transmitting a signal and analyzing the reflected echo to determine range and position of a target B) Only receiving signals passively C) Only optical detection D) Only ground wave propagation

Answer: A

8. Radar frequency bands are typically designated using letter names such as:

A) A, B, C only B) L, S, C, X, Ku bands, etc. C) Only Greek letters D) Only numeric MHz values without names

Answer: B

9. The Radar Range Equation relates the maximum detection range to factors such as:

A) Transmitted power, antenna gain, target cross-section, and receiver sensitivity B) Only transmitted power C) Only antenna color D) Only the operator's skill

Answer: A

10. A pulse radar system operates by:

A) Continuously transmitting an unmodulated wave B) Transmitting short pulses and measuring the time delay of the echo to determine range C) Only receiving signals
D) Transmitting light pulses through fiber

Answer: B

11. In a pulse radar block diagram, the duplexer is used to:

A) Allow the same antenna to be used for both transmission and reception B) Generate the microwave pulses C) Detect the target directly D) Amplify the received video signal

Answer: A

12. RADAR applications include:

A) Air traffic control, weather monitoring, and military surveillance B) Only mobile phone communication C) Only satellite TV D) Only optical fiber links

Answer: A

13. Microwave transmitters and receivers typically operate in the frequency range of:

A) A few Hz to kHz B) 300 MHz to 300 GHz C) DC only D) Optical frequencies

Answer: B

14. Waveguide Tees such as E-plane and H-plane tees mainly differ in:

A) Their color B) The orientation of the electric or magnetic field arm relative to the main waveguide C) Their use only in optical fiber D) Their use only for antennas

Answer: B

15. A directional coupler is characterized by parameters such as:

A) Directivity and coupling factor B) Only insertion loss C) Only VSWR D) Only bandwidth

Answer: A

16. Klystron amplifiers are commonly used in applications requiring:

A) High-power microwave amplification, such as in radar transmitters B) Low-power audio amplification C) Optical signal amplification D) DC power supply

Answer: A

17. The cavity resonators in a klystron are used to:

A) Store optical energy B) Bunch and extract energy from the electron beam at microwave frequencies C) Generate DC bias only D) Reflect light waves

Answer: B

18. A magnetron's crossed-field interaction occurs between:

A) Two magnetic fields only B) An electric field and a magnetic field perpendicular to each other C) Two electric fields only D) Light waves and sound waves

Answer: B

19. In radar systems, target detection range increases with:

A) Decreasing transmitted power B) Increasing transmitted power and antenna gain
C) Decreasing antenna gain D) Increasing receiver noise

Answer: B

20. The radar X-band is commonly used for:

A) Weather radar and military applications B) Only AM broadcasting C) Only optical fiber communication D) Only satellite TT&C

Answer: A

21. The primary function of a radar receiver is to:

A) Transmit the pulse B) Detect and process the weak reflected echo signal C) Generate the transmitted power D) Only power the antenna

Answer: B

2. Analytical MCQs (9)

22. If the transmitted power of a radar system is increased while all other parameters remain constant, according to the radar range equation, the maximum detection range will:

A) Decrease B) Increase (proportional to the fourth root of power) C) Remain unchanged D) Become negative

Answer: B

23. A radar needs to detect small targets at long range with fine angular resolution. This generally favors the use of:

A) Lower frequency bands with larger antennas B) Higher frequency bands (e.g., X-band or Ku-band), providing narrower beamwidths for a given antenna size C) Only optical detection D) Only ground wave propagation

Answer: B

24. A microwave engineer wants to sample a small fraction of forward power in a waveguide without significantly disturbing the main signal. The appropriate component to use is:

A) A directional coupler B) A magnetron C) A klystron D) A radar antenna

Answer: A

25. Comparing klystron and magnetron as microwave sources, the magnetron is generally preferred in applications requiring:

- A) Highly stable, low-noise amplification with an external drive signal
- B) Compact, high-power pulsed oscillation, such as in radar transmitters and microwave ovens
- C) Reception of signals only
- D) Optical signal detection

Answer: B

26. If the radar cross-section of a target decreases (e.g., a stealth aircraft), the radar range equation predicts that the maximum detection range will:

- A) Increase
- B) Decrease
- C) Remain the same
- D) Become infinite

Answer: B

27. A pulse radar system needs the same antenna for both transmitting the pulse and receiving the echo without them interfering. This requires:

- A) Two separate antennas, always
- B) A duplexer to switch the antenna between transmit and receive modes
- C) A directional coupler only
- D) A magnetron only

Answer: B

28. For long-range air traffic control radar requiring wide area coverage at moderate resolution, a lower frequency band such as L-band or S-band is often chosen because it offers:

- A) Very high resolution but short range
- B) Lower atmospheric attenuation and longer range, at the cost of some resolution
- C) No penetration through rain
- D) Only short-range detection

Answer: B

29. In a two-cavity klystron, increasing the beam voltage (within operational limits) primarily affects:

- A) The electron beam velocity and hence the operating frequency/gain characteristics
- B) The optical output only
- C) The antenna gain
- D) The transmission line impedance

Answer: A

30. A weather radar needs to detect precipitation while minimizing interference from ground clutter. This is typically achieved through a combination of:

- A) Appropriate frequency band selection and signal processing techniques (e.g., pulse Doppler, clutter rejection)
- B) Using only a magnetron
- C) Ignoring the radar range equation
- D) Removing the duplexer

Answer: A

PART - B

1. Descriptive Questions (4)

1. Draw and explain the block diagram of a microwave transmitter and receiver, and describe the function of waveguide Tees and directional couplers.
2. Explain the working principle of a two-cavity klystron with a neat diagram.

3. Explain the working principle of a magnetron and list its applications.
4. Explain the working principle of a RADAR system and describe the various radar frequency bands.

2. Analytical Descriptive Question (1)

5. Explain the radar range equation qualitatively and analyze how each parameter (transmitted power, antenna gain, radar cross-section, wavelength, and receiver sensitivity) affects the maximum detection range of a radar system. Use this analysis to justify design choices for a long-range air surveillance radar versus a short-range weather radar.

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