GUJARAT TECHNOLOGICAL UNIVERSITY

BE-6 SEMESTER – OLD PAPER – S22 TO W25 – QUESTION BANK

Subject Name & Code:

FIBER OPTIC COMMUNICATION (3161005)

Unit 1: Overview of Optical fiber Communications

Repeated Questions:

1. **Explain the advantages of the optical communication system using optical fiber over conventional copper system as a transmission link.**
   (W24 - Q1b, 04 marks)
   (W24 - Q1c, 07 marks) [Also covers transmission windows]
   (S25 - Q2 OR, 07 marks)
   (W22 - Q1c, 07 marks)
   (S24 - Q3a, 03 marks)
2. **Draw and Explain block diagram of Optical fiber communication, and mention functions of each block.**
   (S22 - Q1c, 07 marks)
   (S25 - Q2c, 07 marks)
   (W24 - Q3c, 07 marks)
3. **Explain the three transmission windows of Optical fiber communication with diagram.**
   (S24 - Q1a)
   (S25 - Q3a, 03 marks)

Other Important Questions:

4. **Briefly describe the block diagram of Optical communication systems.** (S23 - Q1b)
5. **List any three advantages of fiber optic communication.** (W23 - Q1a, 03 marks)
6. **Calculate the carrier frequency and photon energy (in eV) for the following optical communication systems: (i) Operating at 1.3μm and (ii) operating at 1.5μm.** (W23 - Q1b)
7. **Describe Fiber structure with neat diagram.** (S22 - Q1b, 04 marks) (S25 - Q1a, 03 marks)
8. **Define following: 1) Normalized frequency of fiber, 2) Mode volume for step index fiber, 3) Mode volume for graded index fiber.** (S22 - Q1a)
9. **Define following: 1) Normalized frequency of fiber, 2) Mode volume for step index fiber, 3) Mode volume for graded index fiber, 4) Critical angle, 5) Total internal reflection, 6) Index difference, 7) Numerical Aperture.** (S25 - Q1c, 07 marks)
10. **State and explain Snell's law.** (S25 - Q2a, 03 marks)
11. **Compare Single-mode fiber with Multi-mode fiber.** (S25 - Q2b, 04 marks)

Unit 2: Optical fibers : Structures, Wave guiding and Fabrication

Repeated Questions:

1. **Give the comparison of Step Index (S.I.) and Graded Index (G.I.) fibers.**
   (S22 - Q2 OR (c), 04 marks)
   (S23 - Q2a, 03 marks)
   (S24 - Q1b, 04 marks)
   (S25 - Q1b, 04 marks)
   (W22 - Q3b, 04 marks)
   (W23 - Q3a, 03 marks)
   (W24 - Q2b, 04 marks)
2. **With figure explain The Modified Chemical Vapour Deposition (MCVD) method of fiber fabrication in detail. What are its advantages and disadvantages?**
   (W25 - Q3c, 07 marks)
3. **With figure explain The Plasma Chemical Vapour Deposition (PCVD) method for the production of an optical fiber. What are its advantages?**
   (W25 - Q4c, 07 marks) (W24 - Q2b, 04 marks)
4. **Describe multimode step index, single mode step index and graded index fiber with the aid of simple ray diagrams. Compare the advantages and disadvantages of these fibers for use as an optical channel.**
   (W24 - Q2 OR, 07 marks)

Other Important Questions:

5. **Describe single mode fibers and multimode fibers with necessary figures and write the equation for number of modes supported by multi mode fiber.** (W25 - Q1b)
6. **Define: (1) Refractive index of a material. (2) Critical angle with figure. (3) Total internal reflection.** (W25 - Q1a)
7. **Define V number or Normalized frequency with equation.** (W25 - Q2a, 03 marks)
8. **A graded index fiber has a core with a parabolic refractive index profile which has a diameter of 45µm. The fiber has numerical aperture of 0.25. Estimate the total number of guided modes propagating in the fiber when it is operating at a wavelength of 1.5µm.** (W25 - Q2b)
9. **Describe propagation of a light signal through a single mode step index fiber and multi mode step index fiber with necessary figures.** (W25 - Q2c)
10. **Define skew rays with the help of a figure.** (W25 - Q3a, 03 marks)
11. **An optical fiber with refractive index of core 1.50 and the refractive index of cladding is 1.45, calculate: (1) Critical angle (2) Numerical aperture (3) Acceptance angle** (W25 - Q3b)
12. **A step index fiber in air has a NA of 0.16, a core refractive index of 1.45 and a core diameter of 60µm. Determine the normalized Frequency for the fiber when light at a wavelength of 0.82µm is transmitted. Estimate the number of guided modes propagating in the fiber.** (W25 - Q3 OR a)
13. **Discuss fiber fabrication technique along with the schematic of a fiber drawing apparatus. Explain Outside Vapour-Phase Oxidation technique for the production of optical fiber.** (S24 - Q2c)
14. **Draw and explain schematic of a fiber drawing apparatus.** (W22 - Q2a, 03 marks)
15. **Explain double crucible method of fiber fabrication.** (S23 - Q4b, 04 marks) (W22 - Q4b, 04 marks)
16. **Compare Ray theory and Electromagnetic mode theory for light propagation through fiber.** (W24 - Q4b, 04 marks)
17. **Explain the electromagnetic mode theory for light propagation through fiber.** (W22 - Q2 OR, 07 marks)
18. **Classify the optical fiber according to refractive index profile and materials used to make optical fiber and explain both of them in detail.** (S24 - Q5 OR c)
19. **Using simple ray theory, describe the mechanism for the transmission of light Within an**

optical fiber and show how acceptance angle is related to the fiber numerical aperture. (S23 - Q1c)

Unit 3: Signal Degradation in Optical Fibers

Repeated Questions:

1. **What is dispersion in fiber optic communication? Classify different dispersion with reasons. Explain its effect in optical communication. How to reduce the effect of dispersion?**
   (S23 - Q2 OR c)
   (W24 - Q2c, 07 marks)
2. **What are bending losses in fiber optic communication? Describe: (1) Micro bending losses (2) Macro bending losses.**
   (W25 - Q5 OR c, 07 marks)
   (S22 - Q3 OR c, 07 marks)
   (S25 - Q3c, 07 marks)
   (W24 - Q4 OR c, 07 marks)
3. **Give the comparison of intermodal and intramodal dispersion.**
   (S24 - Q2a, 03 marks)

Other Important Questions:

4. **Define signal attenuation and derive its mathematical expression.** (W24 - Q3a, 03 marks)
5. **Why graded index is less affected by dispersion than step index multi-mode optical fibers?** (S22 - Q3a, 03 marks)
6. **Explain Modal noise.** (S22 - Q3b, 04 marks)
7. **Discuss the following for optical fibers: 1) Absorption 2) Rayleigh Scattering** (S22 - Q3 OR b, 04 marks) (S25 - Q3b, 04 marks)
8. **What is Inter Symbol Interference? How it can be eliminated?** (S25 - Q3a, 03 marks)
9. **Explain scattering loss in optical fiber.** (S25 - Q3b, 04 marks)
10. **Summarize the attenuation loss in optical fiber.** (W22 - Q3 OR b)
11. **Explain the Scattering Losses occur in optical fiber.** (W22 - Q3 OR a)
12. **Classify the various types of attenuations observed in fiber optic communication.** (W23 - Q2a, 03 marks)
13. **Discuss different types of Attenuation Losses related to optical fiber communication in detail.** (S24 - Q4 OR c)
14. **An optical signal at a specific wavelength has lost 55% of its power after traversing 3.5km of fiber. What is the attenuation in dB/km of this fiber?** (S23 - Q2c)
15. **Derive an expression for pulse broadening due to intermodal dispersion in a multimode step index fiber.** (W23 - Q2c, 07 marks)
16. **Explain the concept of dispersion shifted fibers and dispersion flattened fibers.** (W23 - Q3b, 04 marks)
17. **Explain polarization modal dispersion and its effect on the performance of the optical communication.** (W23 - Q3 OR b, 04 marks)

Unit 4: Optical Sources

Repeated Questions:

1. **Compare LED and LASER diodes as light sources for optical fiber.**
   (W22 - Q3a, 03 marks)
   (S23 - Q4a, 03 marks)
   (S24 - Q4b, 04 marks)
2. **Explain the spontaneous emission in LASER with necessary diagram.**
   (W25 - Q4b, 04 marks)
3. **With figures describe the structure and function of a surface emitting LED. What are the advantages and disadvantages of surface emitting LED?**
   (W25 - Q5 OR c, 07 marks)
   (S24 - Q5b, 04 marks)

Other Important Questions:

4. **Draw and Describe the structure of Planar LED.** (W25 - Q3 OR b, 04 marks)
5. **Give the comparison between Edge Emitter and surface emitter LEDs.** (W25 - Q5b, 04 marks)
6. **List the types of Light Emitting Diodes used in optical system and explain any one of them with required figure.** (S22 - Q3c, 07 marks)
7. **Draw ELED configuration and explain its working in detail.** (W22 - Q2b, 04 marks)
8. **With reference to LED, explain how to achieve. a) a high radiance and high quantum effect b) carrier and optical confinement.** (W22 - Q3c, 07 marks)
9. **Explain the high radiance surface emitting LED. Highlight the drawbacks of it and how it can reduce with the help of edge emitting LED.** (W24 - Q4c, 07 marks)
10. **Explain stimulated emission in LASER.** (W25 - Q4a, 03 marks)
11. **What is 'population inversion' and how it can be achieve?** (W22 - Q3b, 04 marks)
12. **Define: ...Population inversion.** (W24 - Q1c, 07 marks) (S23 - Q5 OR a, 03 marks)
13. **List the key transition processes involved in laser action. Explain any one in brief.** (S25 - Q5 OR a)
14. **Explain the principles of operation of the laser using suitable diagrams.** (W24 - Q3 OR b, 04 marks)
15. **Discuss briefly the distributed feedback LASER with neat sketch.** (W22 - Q3 OR c, 07 marks)
16. **The radiative and nonradiative recombination lifetimes of the minority carriers in the active region of a double-heterojunction LED are 60ns and 100ns respectively. Determine the total carrier recombination lifetime and the power internally generated within the device when the peak emission wavelength is 0.87μm at a drive current of 40 mA.** (W25 - Q5 OR b, 04 marks)
    [Identical numerical in S22 - Q2 OR c, 07 marks]
17. **The radiative and non- radiative recombination life times of the minority carriers in the active region of an LED are 3 ns and 100 ns, respectively. Determine the internal efficiency and the bulk recombination lifetime in absence of self- absorption and recombination at hetero- junction.** (W23 - Q4b, 04 marks)
18. **Derive an equation for wavelength spacing for a LASER. A GaAs LASER emitting at 800 nm has a 400 μm long cavity with refractive index η = 3.6. If gain exceeds the total loss throughout the range of 750nm to 850nm, calculate the number of modes that will exist in the LASER.** (W23 - Q4c, 07 marks)
19. **Calculate the optical power coupled into the fiber by an optical source with a bias current of 20mA and a forward voltage of 1.5V. Assume an internal efficiency of the source as 2% and the coupling efficiency of 30%.** (S23 - Q3a)

Unit 5: Power Launching and Coupling

Repeated Questions:

1. **List the most common type of mechanical misalignment occurring between two joined fibers. Explain in brief anyone.**
   (S22 - Q4a, 03 marks)
   (S25 - Q4a, 03 marks)
   (W22 - Q4a, 03 marks)
2. **Explain following terms: 1) Power launching 2) Coupling efficiency.**
   (S22 - Q4b, 04 marks)
   (S25 - Q4b, 04 marks)

Other Important Questions:

3. **Explain types of Mechanical Misalignment occur during fiber joining process.** (W22 - Q4a, 03 marks)
4. **Explain different fiber 'end face' preparation techniques.** (W22 - Q4 OR a, 03 marks)
5. **What is splicing? Explain different techniques of splicing.** (S23 - Q3c, 07 marks)
6. **List various optical fiber splicing technique. Explain any one technique in brief.** (S25 - Q4 OR c, 07 marks)
7. **What do you mean by splicing? Explain any one splicing technique with diagram.** (S24 - Q5 OR b)
8. **Explain the importance of various lensing schemes for improvement of coupling in optical fibers.** (W23 - Q5b, 04 marks)
9. **Sketch and explain the different lensing scheme to improve coupling efficiency.** (W22 - Q4 OR c, 07 marks)
10. **List the different types of lensing schemes used in fiber optical communication.** (W24 - Q5a, 03 marks)
11. **Two fibers with identical NA and core/cladding dimensions are connected. The refractive index of the core is 1.45. There is a small gap between the two fiber end faces. Determine the loss due to mismatch of refractive indices because of intervention of air in between fiber end faces.** (W23 - Q5c, 07 marks)

Unit 6: Photodetectors

Repeated Questions:

1. **Define the following terms related to photo detector: 1) Responsivity 2) Quantum efficiency 3) Cut-off wavelength.**
   (S22 - Q3 OR a, 03 marks)
   (S23 - Q3 OR a, 03 marks)
2. **Differentiate between p-i-n and avalanche photodiodes.**
   (S22 - Q4b, 04 marks)
   (S25 - Q4 OR b, 04 marks)
3. **Describe The principle, characteristics and operation of Avalanche photo Diode in detail.**
   (W25 - Q4c, 07 marks)
   (S24 - Q4 OR c, 07 marks)

Other Important Questions:

4. **Explain the working principle of Avalanche photo diode.** (W22 - Q3 OR b, 04 marks)
5. **Discuss the advantages and disadvantages of APD over p-i-n.** (W23 - Q4 OR b, 04 marks)
6. **A silicon APD has a quantum efficiency of 75% at a wavelength of 900nm. If 0.5mw of optical power produces a multiplied photo current of 10mA, then what is avalanche gain for this device?** (S23 - Q3 OR b)
7. **An InGaAs p-i-n diode, operating at 1300 nm, has following parameters: $I_D = 4$ nA, $\eta = 0.9$, $R_L = 1000\ \Omega$. The incident optical power is 300 nW and the receiver bandwidth is 20 MHz. Determine values of various noise currents. Assume surface leakage current to be zero.** (W23 - Q4 OR c, 07 marks)
8. **Define: Quantum efficiency, Splicing, Birefringence.** (W23 - Q4 OR a, 03 marks)
9. **Define: Radiance, Responsivity, Population inversion.** (W23 - Q4a, 03 marks)
10. **Define: (i) V number (ii) Responsivity (iii) Spontaneous emission.** (W22 - Q1a, 03 marks)
11. **Define the quantum efficiency & responsivity of a photo detector.** (S24 - Q4a, 03 marks)
12. **Explain detection process in the p-n photodiode. Define the quantum efficiency and responsivity of a photo detector.** (W24 - Q5 OR c, 07 marks)
13. **Describe the principle used in the photo detector.** (S22 - Q5b, 04 marks) (S25 - Q5 OR b)

Unit 7: Optical Receiver Operation

Repeated Questions:

1. **Discuss with the aid of a block diagram, the function of an optical fiber receiver in communication with its components.**
   (S22 - Q5c, 07 marks)
2. **Enlist and explain the factors that decides the performance of optical reception. Draw and explain eye diagram in detail.**
   (W24 - Q4 OR c, 07 marks)

Other Important Questions:

3. **Briefly discuss the possible sources of noise in optical receivers.** (S23 - Q3 OR c, 07 marks)
4. **With a schematic diagram explain the working of optical receiver.** (S24 - Q3 OR c, 07 marks)

Unit 8: Transmission Systems

Repeated Questions:

1. **Discuss optical power loss model for a point-to-point link.**
   (S22 - Q4c, 07 marks)
   (S23 - Q4c, 07 marks)
   (S24 - Q3c, 07 marks)
   (W24 - Q5b, 04 marks)
2. **Calculate the link power budget to construct an optical link of 15KM and a bandwidth of 100Mb/s. Components are chosen with following characteristics: Receiver sensitivity is -50dBm, fiber loss is 2dB/KM and a transmitter launch power of 0dBm, source and detector coupling loss of 1dB each.It is anticipated that 10 splices are required with each of loss of 0.4dB.Determine whether the system operates with sufficient power margin or not.**
   (W22 - Q3 OR b)

Other Important Questions:

3. **For a 30km long fiber the attenuation is 0.8dB/km at a wave length of 1300nm. If a 200µW power is launched into the fiber ,find the output power.** (W25 - Q4b)
4. **A continuous 15km long optical fiber link has a loss of 1.7dB/km. i) What is the minimum optical power level that must be launched into the fiber to maintain as optical power level of 0.3µW at the receiving end. ii) What is the required input power if the fiber has a loss of 2.7dB/km.** (S24 - Q3b)
5. **An 850nm, graded index, multimode 50Mbps fiber optic system with 2dB/km loss is used for a network. The source delivers -16 dBm power with 50nm spectral width and the detector has a sensitivity of -48 dB at 50Mbps. The bandwidth-distance product of the fiber is 500Mbps-km. Determine the number of taps, each with a 0.4dB loss that can be inserted per kilometer without affecting the distance. Also, find the maximum distance that can be covered, without any tap, if the data rate is reduced to 10Mbps.** (W23 - Q3c)
6. **A 6km long fiber optic communication link has following parameters: Combined optical source + drive circuitry rise time=15ns, Spectral width of the source = 40 nm, Receiver front- end bandwidth = 25MHz, Fiber bandwidth- distance product = 400 MHz-km, Fiber material dispersion=0.0875 ns/nm.km. Use your expertise as optical engineer to investigate the suitability of this link to transmit a data rate of 20 Mbps (NRZ). Assume q=0.7.** (W23 - Q3 OR c)
7. **Discuss limitations on BER in optical transmission systems.** (S22 - Q5a, 03 marks)

Unit 9: Optical Amplifiers

Repeated Questions:

1. **Discuss the need of optical amplifier and also describe the architecture and amplification mechanism of Erbium Doped Fiber Amplifier (EDFA).**
   (W22 - Q3 OR c)
   (W24 - Q3 OR c, 07 marks)

Other Important Questions:

2. **Illustrate the forward and backward pumping capability associated with fiber Raman amplifier.** (W25 - Q4a, 03 marks)
3. **How does Raman amplifier work?** (S25 - Q5b, 04 marks)
4. **Mention the applications of Optical amplifier.** (S24 - Q3 OR b, 04 marks)
5. **Explain Erbium Doped Power amplifiers (EDFAs).** (S23 - Q4 OR c, 07 marks)
6. **Draw the schematic structure of the semiconductor optical amplifier and explain its principle.** (W25 - Q5a, 03 marks)

Unit 10: Advances in Optical Fiber Systems

Repeated Questions:

1. **Explain the concept of Wavelength Division Multiplexed Networks (WDM) briefly.**
   (W25 - Q5 OR a, 03 marks)
   (S22 - Q5 OR a, 03 marks)
   (S24 - Q4b, 04 marks)
   (W24 - Q4 OR b, 04 marks)
2. **Write short notes on Synchronous optical fiber networks (SONET).**
   (S22 - Q5 OR c, 07 marks)
   (S25 - Q5c, 07 marks)
   (W22 - Q3 OR)
   (S23 - Q5 OR c, 07 marks)

Other Important Questions:

3. **Explain the basic principles of WDM and DWDM with respect to optical fiber system.** (W22 - Q4c, 07 marks)
4. **Explain the principle of Wavelength Division Multiplexing.** (S23 - Q5a, 03 marks)
5. **Give full forms of: WDM, LAN, SDH.** (W23 - Q5a, 03 marks)
6. **Give full forms of: SONET, EDFA, RAPD.** (W23 - Q5 OR a, 03 marks)

Unit 11: Overview of Optical Components

Other Important Questions:

1. **Explain the 2×2 Fiber Coupler and its function.** (W24 - Q5 OR b, 04 marks) (S23 - Q5 OR a, 03 marks)
2. **Explain the working principle of star coupler.** (S24 - Q4 OR a, 03 marks)
3. **Explain Mach- Zehnder Interferometer (MZI) Multiplexer in detail.** (S23 - Q5c, 07 marks)
4. **Explain the principle of Mach- Zehnder interferometer.** (W23 - Q5 OR b, 04 marks)
5. **Consider the case of the determination of a crack in a single mode fiber whose core refractive index is 1.425. Assume that the OTDR emits wavelength to excite only a single mode. Determine the error in crack location if n_eff = 1.42 is used. The round trip delay found is τ = 100 μs.** (W23 - Q5 OR c, 07 marks)

Unit 12: Fiber Optical Measurements

Repeated Questions:

1. **Explain OTDR method with its benefits over other techniques.**
   (S23 - Q5 OR b, 04 marks)
   (S24 - Q5c, 07 marks)

Other Important Questions:

2. **Explain the experimental method to measure Numerical Aperture(NA) and derive the relevant mathematical expression for NA using the same.** (W23 - Q2 OR c, 07 marks)
3. **State methods for dispersion measurement in laboratory. Explain the experimental setup for one of them.** (S25 - Q5 OR c)
4. **Explain any one method for optical dispersion measurement.** (W24 - Q5 OR a, 03 marks)

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