

GUJARAT TECHNOLOGICAL UNIVERSITY**BE- SEMESTER-VI EXAMINATION – WINTER 2025****Subject Code:3161005****Date:17-11-2025****Subject Name:Fiber Optic Communication****Time:02:30 PM TO 05:00 PM****Total Marks:70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

		MARKS
Q.1	(a) Define: (1) Refractive index of a material. (2) Critical angle with figure. (3) Total internal reflection.	03
	(b) Describe single mode fibers and multimode fibers with necessary figures and write the equation for number of modes supported by multi mode fiber.	04
	(c) Explain the advantages of fiber optic communication system in detail.	07
Q.2	(a) Define V number or Normalized frequency with equation.	03
	(b) A graded index fiber has a core with a parabolic refractive index profile which has a diameter of 45 μm .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 1.5 μm .	04
	(c) Describe propagation of a light signal through a single mode step index fiber and multi mode step index fiber with necessary figures.	07
OR		
	(c) What is dispersion in fiber optic communication? Describe: (1) Material dispersion (2) Wave guide dispersion in detail.	07
Q.3	(a) Define skew rays with the help of a figure.	03
	(b) 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	04
	(c) With figure explain The Modified Chemical Vapour Deposition (MCVD) method of fiber fabrication in detail. What are its advantages and disadvantages?	07
OR		
Q.3	(a) A step index fiber in air has a NA of 0.16, a core refractive index of 1.45 and a core diameter of 60 μm .Determine the normalized Frequency for the fiber when light at a wavelength of 0.82 μm is transmitted. Estimate the number of guided modes propagating in the fiber.	03
	(b) Draw and Describe the structure of Planar LED.	04
	(c) With figure explain The Plasma Chemical Vapour Deposition (PCVD) method for the production of an optical fiber. What are its advantages?	07
Q.4	(a) Illustrate the forward and backward pumping capability associated with fiber Raman amplifier.	03
	(b) For a 30 km long fiber the attenuation is 0.8 dB/km at a wave length of 1300nm.If a 200 μW power is launched into the fiber ,find the output power.	04

- (c) Define scattering losses and explain linear scattering losses in detail. **07**
- OR**
- Q.4** (a) Explain stimulated emission in LASER. **03**
- (b) Explain the spontaneous emission in LASER with necessary diagram. **04**
- (c) Describe The principle, characteristics and operation of Avalanche photo Diode in detail. **07**
- Q.5** (a) Draw the schematic structure of the semiconductor optical amplifier and explain its principle. **03**
- (b) Give the comparison between Edge Emitter and surface emitter LEDs **04**
- (c) What are the bending losses in fiber optic communication? **07**
Describe: (1) Micro bending losses (2) Macro bending losses.
- OR**
- Q.5** (a) Explain the concept of Wavelength Division Multiplexed Networks (WDM) briefly. **03**
- (b) 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 0.87 μm at a drive current of 40mA. **04**
- (c) With figures describe the structure and function of a surface emitting LED. What are the advantages and disadvantages of surface emitting LED? **07**

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER-VI (NEW) EXAMINATION – WINTER 2024

Subject Code:3161005

Date:25-11-2024

Subject Name:Fiber Optic Communication

Time:02:30 PM TO 05:00 PM

Total Marks:70

Instructions:

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

- Q.1**
- (a) Explain Total internal reflection with the help of figure and its significance in fiber optic communication. **03**
- (b) Explain the advantages of the optical communication system using optical fiber over conventional copper system as a transmission link. **04**
- (c) Define the following. (Draw necessary figures and write equations if any) **07**
- i) Critical angle
 - ii) Numerical aperture
 - iii) Rayleigh Scattering
 - iv) Population inversion

- Q.2**
- (a) Explain Snell's law with the help of figure and equations. **03**
- (b) Explain the plasma activated chemical vapor deposition (PCVD) technique for the production of optical fiber. **04**
- (c) Give classification of dispersion and explain its effect in fiber optic communication. Mention different ways to reduce it. **07**

OR

- (c) 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. **07**
- Q.3**
- (a) Define signal attenuation and derive its mathematical expression. **03**
- (b) Give the comparison of Step Index and Graded Index fibers. **04**
- (c) Describe working of an optical fiber communication system with proper block diagram in detail. **07**

OR

- Q.3**
- (a) What is equilibrium numerical aperture. Give the significance of the same. **03**
- (b) Explain the principles of operation of the laser using suitable diagrams. **04**
- (c) Discuss the significance of optical amplifier in fiber optic communication. Describe the architecture and amplification mechanism of Erbium Doped Fiber Amplifier (EDFA). **07**

- Q.4 (a)** Mention the principal requirements of good optical fiber connectors. **03**
- (b)** Compare Ray theory and Electromagnetic mode theory for light propagation through fiber. **04**
- (c)** Explain the high radiance surface emitting LED. Highlight the drawbacks of it and how it can reduce with the help of edge emitting LED. **07**

OR

- Q.4 (a)** Explain the principal of optical detection. **03**
- (b)** Explain the features of Wavelength Division Multiplexing. **04**
- (c)** Enlist and explain the factors that decides the performance of optical reception. Draw and explain eye diagram in detail. **07**
- Q.5 (a)** List the different types of lensing schemes used in fiber optical communication. **03**
- (b)** Discuss optical power loss model for a point-to-point link. **04**
- (c)** Explain Synchronous optical fiber networks (SONET) in detail. **07**

OR

- Q.5 (a)** Explain any one method for optical dispersion measurement. **03**
- (b)** Explain the 2x2 Fiber Coupler and its function. **04**
- (c)** Explain detection process in the p-n photodiode. Define the quantum efficiency and responsivity of a photo detector. **07**

Seat No.: _____

Enrolment No. _____

GUJARAT TECHNOLOGICAL UNIVERSITY
BE - SEMESTER-VI (NEW) EXAMINATION – WINTER 2023

Subject Code:3161005

Date:05-12-2023

Subject Name:Fiber Optic Communication

Time:02:30 PM TO 05:00 PM

Total Marks:70

Instructions:

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
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4. Simple and non-programmable scientific calculators are allowed.

		MARKS
Q.1	(a) List any three advantages of fiber optic communication.	03
	(b) Calculate the carrier frequency and photon energy (in eV) for the following optical communication systems: (i) Operating at 1.3 μm and (ii) operating at 1.5 μm .	04
	(c) A step index fiber has following parameters: $n_1=1.475$, $n_2=1.460$ and core radius of 25 μm . Determine (i) Total number of reflections over a length of 1 km of the fiber. (ii) The total loss over 1 km, if the power loss is 0.01% at each reflection,	07
Q.2	(a) Classify the various types of attenuations observed in fiber optic communication.	03
	(b) A point source of light is 12 cm below the surface of a large body of water ($n=1.33$). Find the radius of the largest circle on the water surface through which the light can emerge.	04
	(c) Derive an expression for pulse broadening due to intermodal dispersion in a multimode step index fiber.	07
	OR	
	(c) Explain the experimental method to measure Numerical Aperture(NA) and derive the relevant mathematical expression for NA using the same.	07
Q.3	(a) Compare step index fiber with graded index fiber.	03
	(b) Explain the concept of dispersion shifted fibers and dispersion flattened fibers.	04
	(c) An 850 nm, graded index, multimode 50 Mbps fiber optic system with 2dB/km loss is used for a network. The source delivers -16 dBm power with 50 nm spectral width and the detector has a sensitivity of -48 dB at 50 Mbps. The bandwidth-distance product of the fiber is 500 Mbps-km. Determine the number of taps, each with a 0.4 dB 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 10 Mbps.	07
	OR	
Q.3	(a) Compare single mode fiber with multimode fiber.	03
	(b) Explain the polarization modal dispersion and its effect on the performance of the optical communication.	04
	(c) A 6 km long fiber optic communication link has following parameters:	07

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 $q=0.7$.

- Q.4** (a) Define: Radiance, Responsivity, Population inversion **03**
(b) 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. **04**
(c) 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 $n=3.6$. If gain exceeds the total loss throughout the range of 750nm to 850nm, calculate the number of modes that will exist in the LASER. **07**

OR

- Q.4** (a) Define: Quantum efficiency, Splicing, Birefringence **03**
(b) Discuss the advantages and disadvantages of APD over p-i-n. **04**
(c) An InGaAs p-i-n diode, operating at 1300 nm, has following parameters: $I_D=4\text{ nA}$, $\eta=0.9$, $R_L=1000\ \Omega$. 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. **07**

- Q.5** (a) Give full forms of: WDM, LAN, SDH **03**
(b) Explain the importance of various lensing schemes for improvement of coupling in optical fibers. **04**
(c) 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. **07**

OR

- Q.5** (a) Give full forms of: SONET, EDFA, RAPD **03**
(b) Explain the principle of Mach-Zehnder interferometer. **04**
(c) 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 $n_{\text{eff}}=1.42$ is used. The round trip delay found is $\tau=100\ \mu\text{s}$. **07**

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER-VI(NEW) EXAMINATION – WINTER 2022****Subject Code:3161005****Date:14-12-2022****Subject Name:Fiber Optic Communication****Time:02:30 PM TO 05:00 PM****Total Marks:70****Instructions:**

1. Attempt all questions.
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MARKS

- Q.1**
- | | | |
|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| (a) | Define: (i) V number (ii) Responsivity (iii) Spontaneous emission | 03 |
| (b) | Give in brief the comparison of S.I. and G.I. fibers. | 04 |
| (c) | Explain the advantages of the optical communication system using optical fiber over conventional copper system as a transmission link. State the optical transmission windows. | 07 |
- Q.2**
- | | | |
|-----|-------------------------------------------------------------------------------|-----------|
| (a) | Draw and explain schematic of a fiber drawing apparatus. | 03 |
| (b) | Draw ELED configuration and explain its working in detail. | 04 |
| (c) | Define Numerical Aperture and derive its expression for the step index fiber. | 07 |
- OR**
- | | | |
|-----|------------------------------------------------------------------------------|-----------|
| (c) | Explain the electromagnetic mode theory for light propagation through fiber. | 07 |
|-----|------------------------------------------------------------------------------|-----------|
- Q.3**
- | | | |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| (a) | Compare LED and LASER diodes as light sources for optical fiber. | 03 |
| (b) | What is 'population inversion' and how it can be achieve? | 04 |
| (c) | With reference to LED, explain how to achieve. <ol style="list-style-type: none"> a) a high radiance and high quantum effect b) carrier and optical confinement. | 07 |
- OR**
- Q.3**
- | | | |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| (a) | A step index fiber in air has a numerical aperture of 0.16, a core refractive index of 1.45 and a core diameter of 60 μm . Calculate refractive index of cladding, relative refractive index difference (Δ) and acceptance angle. | 03 |
| (b) | Explain the working principle of Avalanche photo diode. | 04 |
| (c) | Discuss briefly the distributed feedback LASER with neat sketch. | 07 |
- Q.4**
- | | | |
|-----|------------------------------------------------------------------------------------|-----------|
| (a) | Explain types of Mechanical Misalignment occur during fiber joining process. | 03 |
| (b) | Explain double crucible method of fiber fabrication. | 04 |
| (c) | Explain the basic principles of WDM and DWDM with respect to optical fiber system. | 07 |
- OR**
- Q.4**
- | | | |
|-----|---------------------------------------------------------------------------------|-----------|
| (a) | Explain different fiber 'end face' preparation techniques. | 03 |
| (b) | What is dispersion in fiber optic communication? Describe: Material dispersion | 04 |
| (c) | Sketch and explain the different lensing scheme to improve coupling efficiency. | 07 |

- Q.5 (a)** What is dispersion in optical fiber? How to reduce the effect of dispersion? **03**
- (b)** Summarize the attenuation loss in optical fiber. **04**
- (c)** Write short notes on Synchronous optical fiber networks(SONET) **07**
- OR**
- Q.5 (a)** Explain the Scattering Losses occur in optical fiber. **03**
- (b)** 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. **04**
- (c)** Discuss the need of optical amplifier and also describe the architecture and amplification mechanism of Erbium Doped Fiber Amplifier. (EDFA). **07**
