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.**
3. **Figures to the right indicate full marks.**
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 (η=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 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. **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 nA, η=0.9, R_L=1000 Ω. 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_{eff}=1.42 is used.The round trip delay found is τ=100 μs. **07**

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