FIRST INTERNAL ASSESSMENT

Sem: VIII
Date: 14/03/2019

Sub: Fiber Optics and N/W
Time: 3.00-4.00 pm

Sub. Code: 15EC82
Max. Marks:25

Note: Answer two full questions, draw sketches wherever necessary.

Q. No		Description of Question	Marks	CO	RBT LEVEL
1	a	Obtain the expression for maximum acceptance angle of a step-index fiber using a suitable diagram and define Numerical Aperture.	6	C402.1	L1,L2
	b	A GI fiber has parabolic refractive index with core index of 1.5, diameter of 50μm and NA of 0.2. Calculate number of modes of the fiber supports at 1.0 μm.	7	C402.1	L1,L2
		OR			
2	a	Compare the three types of fiber (SMSI, MMSI and GI) in terms of various parameters using suitable diagram.	6	C402.1	L1,L2
	b	A MMSI fiber has NA of 0.2 and supports 1000 modes at 850nm wavelength. Calculate diameter of core, number of modes the fiber supports at 1320nm.	7	C402.1	L1,L2
3	a	Define signal attenuation in fibers. Explain atomic absorption factors responsible for signal attenuation.	6	C402.2	L1,L2
	b	When mean optical power launched into 8km fiber is 12μW, the mean optical power at fiber output is 3μW. Calculate overall attenuation in db. For 10km length link if splices are done for every km interval with 1db splice attenuation, What will be overall signal attenuation?	6	C402.2	L1,L2
		OR			
4	a	Discuss Scattering losses and Radiation losses in optical fibers.	6	C402.2	L1,L2
	b	For a 20km long fiber, attenuation is 0.6db/km at 1300nm. If 200μW power is launched into fiber, Calculate the output power.	6	C402.2	L1,L2

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IA -1 SCHEME OF EVALUATION

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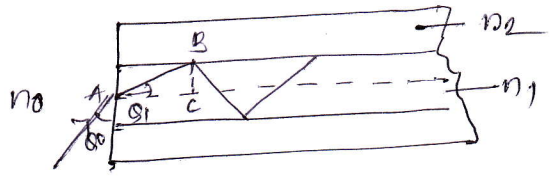
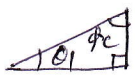
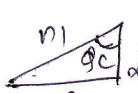
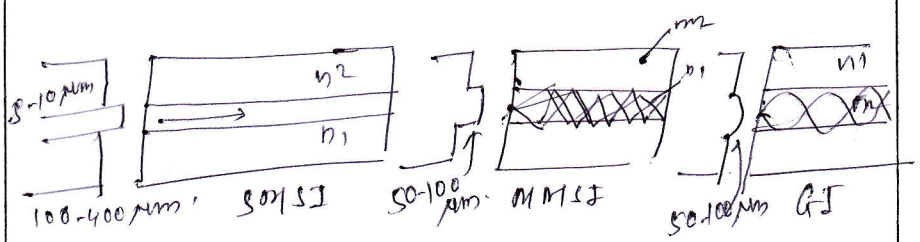
Q. No.	Bit	Description	Marks	CO's	RBT LEVEL
1.	a.	 ① $n_1 > n_2$ ② $\phi \geq \phi_c$ $n_0 \sin\theta_0 = n_1 \sin\theta_1$ ——— ① at pt. A  from Δ $\theta_1 = 90 - \phi$ $\sin\theta_0 = \frac{n_1}{n_0} \sin(90-\phi) \cdot \cos\phi$  $\sin\phi_c = \frac{n_2}{n_1} \Rightarrow \cos\phi_c = \frac{\sqrt{n_1^2 - n_2^2}}{n_1}$ $\therefore \sin\theta_{0max} = \frac{n_1}{n_0} \cos\phi_c = \frac{n_1}{n_0} \frac{\sqrt{n_1^2 - n^2}}{n_1}$ $= \sqrt{n_1^2 - n_2^2} = \sin\theta$ NA : defined as light gathering capacity of a fibre $NA = \sin\theta_{0max} = \sqrt{n_1^2 - n_2^2}$	6.	C402.1	L2
2	a.	 Source Laser Laser/LED			
1	b.	$n_1 = 1.5$ $d = 50\mu m \Rightarrow a = 25\mu m$ $NA = 0.2$ —— 1M $\lambda = 1\mu m$ $M = ?$ $V = \frac{2\pi a}{\lambda} NA = \frac{2\pi \times 25 \times 10^{-6}}{1 \times 10^{-6}} \times 0.2 = 31.4$ —— 3M $M_g = \frac{V^2}{4} = \frac{32^2}{4} = \frac{986}{4} = 247$ —— 3M.	7.	C402.1	L2

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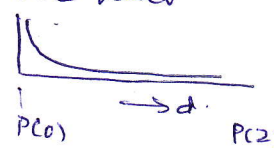
Q. No.	Bit	Description	Marks	CO's	RBT LEVEL
2	b	NA = 0.2 M = 1000 λ = 850nm a = ? M = ? at 1320nm. $V = \frac{2\pi a}{\lambda} NA \Rightarrow a = \frac{V\lambda}{2\pi NA}$ $M = \frac{V^2}{2} = \frac{1}{2}\left[\frac{2\pi a}{\lambda} NA\right]^2$ $1000 \times 2 = \left[\frac{2\pi a}{850\times10^{-9}} \times 0.2\right]^2 \Rightarrow a = 60.49$ um $M = \left[\frac{2\pi \times 60.49}{1320\times10^{-9}} \times 0.2\right]^2 = 207.7 \approx 208$.	7	CLO2.1	L2,
3	a	α = attn. is measure of signal decay along the fiber			
	b	 $P(z) = P(0)e^{-\alpha_p z} \Rightarrow \alpha_p = \frac{1}{z}\ln\left[\frac{P(0)}{P(z)}\right]$ $\alpha_{(dB/km)} = \frac{10}{z}\log\left[\frac{P(0)}{P(z)}\right]$	6	CLO3.2	L2
		Absorption:- 1) Due to atomic defects in glass composition. 2) Intrinsic absorption. 3) Extrinsic absorption.			
	b)	z = 8km P(0) = 12 uW P(z) = 3 uW $\alpha = \frac{10}{8}\log\left[\frac{12}{3}\right] = 0.75$ db/km.	6	CLO3.2	L2
		for 10km ~~portion~~ splices → no. of splices = 9 α = 6.75db α for 8km = 8km x 0.75 = 6db. ∴ overall attn = 6.75 + 6 = 12.75 db.			
4	a	Scattering loss < linear scattering < Rayleigh's i.e.; Nonlinear scattering < Raman, Brillouin			
		Rayleigh's Scattering: $\alpha_R = \frac{8\pi^3}{3\lambda^4} n^8 p^2 K_B T_f \beta_T$ $\alpha = 10\log(1/1_R)$.			

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Q. No.	Bit	Description	Marks	CO's	RBT LEVEL
		Mie scattering: non perfect cylindrical structure of the fiber. controlling fiber coating, $\uparrow\Delta$, imperfections during fabrication. **Radiation losses:-** Microbending losses - bending radius is comparable with fiber radius. **Macrobending losses:-** Bending radius is non-comparable with radius of fiber $R_c \propto \frac{20\lambda}{(n_1-n_2)^{3/2}}\left[2748 - .996\,\lambda/\lambda_c\right]^{-3}$	(6)	C402.2	L2
	b)	$Z = 20\text{km}$ $\alpha = 0.6\text{dB/km}$ $P(0) = 200\mu\text{W}$ $\alpha = \frac{10}{Z}\log\left(\frac{P(0)}{P(z)}\right)$ $0.6 = \frac{10}{20}\log\left[\frac{200\mu}{P(z)}\right]$ $\Rightarrow P(z) = 12.6\mu\text{W}$	(6)	C402.2	L2

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