Total number of printed pages: **Programme (UG) 8th Semester/UECE811A**

2024

Optical Communication

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions.*

1	(a)	What are the major advantages of optical fiber communication?	6
	(b)	What does numerical aperture of an optical fiber means? With suitable ray diagram derived the formula for numerical aperture in terms of acceptance angle and relative refractive index.	2+5
	(c)	A silica optical fiber with a core diameter large enough to be considered by ray theory analysis has a core refractive index of 1.5 and a cladding refractive index of 1.47. Determine: (i) the critical at the core-cladding interface (ii) the NA for the fiber (iii) the acceptance angle in air for the fiber.	7
2	(a)	With the neat sketch describe the ray transmission in Step Index Fiber (SIF) for multimode and single mode.	5
	(b)	With the neat sketch describe the ray transmission in Graded Index Fiber for multimode and skew ray.	5
	(c)	What is "V" number? Derive the relation with relative refractive index.	5
	(d)	Prove that the number of modes propagating through the step index fiber is two times the number of modes propagating through the graded index fiber with $\alpha=2$.	5
3	(a)	What is dispersion? Discuss the different types of dispersions present in optical fiber and their origination.	2+8
	(b)	What are link power budget and rise time budget? Discuss each of them	5+5
4	(a)	What are the basic requirements of the optical source for optical communication?	5
	(b)	What are injection efficiency, radiative recombination efficiency and extraction efficiency in connection with LED? Derive the expression of	5

		injection efficiency.	
	(c)	Discuss with suitable diagram why is dome shaped LED very popular?	4
	(d)	The external power efficiency of a planer GaAs LED is 1.5% when the forward current is 50mA and the potential difference across its terminal is 2V.Estimate the optical power generated within the device if the transmission factor at the coated GaAs air interface is 0.8.	6
5	(a)	What is the main advantage of Avalanche Photo Diode? Discuss qualitatively the avalanche multiplication process in APD?	2+3
	(b)	Deducing the necessary equations prove that at breakdown in APD (i) $\int_0^W \alpha_e dx = 1$ $when\ \alpha_e = \alpha_h$ and (ii) $\int_0^W \alpha_h \exp[\int_0^x (\alpha_h - \alpha_e)dx']dx = 1$ $when\ \alpha_e \neq \alpha_h$ and the avalanche process is initiated by electrons. Where the symbols are their usual meanings.	15
6	(a)	With the suitable energy level diagram describe the process of population inversion of a two level system. How do the drawbacks of the two level systems can be overcome by using a three level system and the drawbacks of three level systems by four level systems?	6+2+2
	(b)	With the suitable schematic diagram derive the threshold condition for laser oscillation in a Fabry-Perot cavity $g_{th} = \gamma + \frac{1}{2l} ln\left(\frac{1}{R_1 R_2}\right)$. Where $g_{th}, \gamma, l, R_1, R_2$ are the threshold gain, loss co-efficient, length of the cavity and reflection coefficients at the two ends.	10
7	(a)	What does coupling efficiency in an optical fiber mean? How this efficiency is varies with α for a graded index fiber?	3+2
	(b)	What is equivalent numerical aperture? Discuss how the numerical aperture changes with fiber length.	2+3
	(c)	Discuss the different types of splice/connector losses in optical fiber communication systems.	4
	(d)	Discuss the different key system requirements to design an optical point-to-point link and discuss to fulfill these requirements what type of components & their associate characteristics a designer must have to take in account.	2+4