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Total Pages : 05

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M. Sc. (Physics) (Fourth Semester)

Optical Fiber Communication (MPE-404)

Time : 3 Hours]

[Maximum Marks : 75

Note : It is compulsory to answer all the questions (1.5 marks each) of Part A in short. Answer any *four* questions from Part B in detail. Different sub-parts of a question are to be attempted adjacent to each other.

**Part A**

1. (a) Define numerical aperture and state its physical significance. 1.5
- (b) Distinguish between meridional rays and skew rays. 1.5

- (c) What is group index ? How is it related to group velocity ? 1.5
- (d) Explain the significance of refractive index profile parameter. 1.5
- (e) Define quantum efficiency of a photodetector. 1.5
- (f) What is population inversion in lasers ? 1.5
- (g) Write *four* qualities of an optical detector. 1.5
- (h) What is modal dispersion ? 1.5
- (i) Define responsivity of a photodiode. 1.5
- (j) What is the role of cladding in optical fibers ? 1.5

### Part B

2. (a) Explain the principle of light propagation in optical fibers based on total internal reflection. Derive an expression for numerical aperture. 6

- (b) Distinguish between step-index and graded-index fibers. Discuss their relative advantages in communication systems. 6
- (c) A step-index fiber has core refractive index 1.48 and cladding refractive index 1.46. Calculate : 3
- (i) Numerical aperture
- (ii) Acceptance angle in air.
3. (a) Explain electromagnetic wave propagation in a planar waveguide and derive the condition for guided modes. 8
- (b) Explain the working of a PIN photodiode with suitable diagrams. Compare PIN photodiode and Avalanche photodiode (APD). 7
4. (a) Explain the transmission characteristics of optical fibers with particular emphasis on the different attenuation mechanisms. Classify the losses into linear losses and non-linear losses. 10

- (b) Explain the difference between index-guiding photonic crystal fibers and photonic bandgap fibers. 5
5. (a) What are the different methods for fiber fabrication ? Explain any *one* method elaborately with the help of a neat diagram. 10
- (b) Explain the working principle of optical fiber sensors. Classify them into intrinsic and extrinsic sensors, and discuss at least *one* example of each. 5
6. (a) Derive Einstein's relations between absorption, spontaneous emission and stimulated emission coefficients. 6
- (b) A light ray propagates through a multimode optical fiber making an angle of  $20^\circ$  with the fiber axis. If the length of the fiber is 3 km, determine the total distance traveled by the ray inside the fiber. 6

- (c) A semiconductor laser emits at 850 nm with output power of 2 mW. Calculate the photon emission rate. 3

7. Write short notes the following : 15
- (a) Fiber couplers
- (b) Fiber materials
- (c) Ruby laser.

