(b) With the help of energy level diagram, explain the principle of operation of EDFA.

5 + 7 = 12

Group - E

8. (a) Describe different network topologies.

(b) Explain the frame structure of SONET.

(c) Describe Different protocol layers of SONET.

4 + 4 + 4 = 12

9. Write short notes on any three of the following: **(3 × 4) = 12**
   (i) SDH
   (ii) Fiber Raman Amplifier
   (iii) Dispersion shifted optical fiber
   (iv) WDM.

FIBER OPTIC COMMUNICATION
(ECEN 3241)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) An absorption caused by valance electrons in the silica material from which the fibers are manufactured
(a) ion resonance absorption (b) UV absorption
(c) modal dispersion (d) IR absorption.

(ii) Type of fiber that has the highest modal dispersion
(a) step index single mode (b) step index multimode
(c) graded index multimode (d) graded index single mode.

(iii) Calculate the energy of the infrared light at 1.55 um
(a) 0.5 eV (b) 1.55 eV
(c) 0.8 eV (d) none.

(iv) Light in a graded index fiber is guided by
(a) total internal reflection (b) refraction
(c) both a & b (d) none.

(v) Which of the following materials is not suitable for making an LED?
(a) GaAs (b) Si
(c) InGaAsP (d) AlGaAS.

(vi) Multimode step index fiber has
(a) large core diameter and large numerical aperture
(b) large core diameter and small numerical aperture
(c) small core diameter and large numerical aperture
(d) small core diameter and small numerical aperture.

(vii) In an optical fiber, the concept of numerical aperture is applicable in describing the ability of
(a) light collection (b) light scattering
(c) light dispersion (d) light polarization.

(viii) In photodiode, when there is no incident light, the reverse current is almost negligible and is called
(a) zener current (b) dark current
(c) photo current (d) PIN current.

(ix) The scheme of WDM is similar to
(a) FDM for RF transmission (b) TDM
(c) SDM (d) OTDM.

(x) Which among the following is a key process adopted for the laser beam formation as it undergoes the light amplification?
(a) Spontaneous Emission (b) Stimulated Emission
(c) Both (a) and (b) (d) None of the above.

Group - B

2. (a) Define (i) Numerical Aperture (ii) normalized frequency or V number of optical fiber.

(b) Explain how the multimode optical rays are propagated through the Graded-Index optical fiber with a suitable diagram.

(c) A cylindrical step index fiber has a core diameter of 100 μm and refractive index of 1.5. The cladding has a refractive index of 1.46. The source is operating at a wavelength of 0.95 μm. Estimate: (i) the normalized frequency for the fiber (ii) the number of guided modes.

(2 + 2) + 3 + 5 = 12

3. (a) Explain ray propagation with a diagram in a graded index optical fiber.

(b) Mention different optical fiber losses.

(c) The speed of light in vacuum and in the core of the SI fiber is 3×10^8 ms^{-1} and 2×10^8 ms^{-1} respectively. When the fiber is placed in air the critical angle at the core cladding interface is 75^0, calculate the (i) NA of the fiber and (ii) multipath time dispersion per unit length.

3 + 4 + 5 = 12

Group - C

4. (a) With neat diagram, explain the operation of edge-emitting double hetero structure LED.

(b) Define Internal Quantum efficiency and External quantum efficiency of an LED.

(c) A Burrus type p-n GaAs (r.i. of 3.6 and band gap 1.43 eV) LED is coupled to a SIF using epoxy resin (r.i. of 1.5). The radiative and non-radiative recombination life times be 50 ns and 100ns respectively. The LED is forward biased with a current of 150 mA and a voltage of 2V. Estimate,
(i) Internal quantum efficiency
(ii) Internal power efficiency
(iii) External quantum efficiency and
(iv) External power efficiency.

4 + 2 + 6 = 12

5. (a) Explain the working principle of distributed Bragg reflector laser with a suitable diagram.

(b) What is population inversion? Find the threshold condition for lasing operation.

(c) A double heterostructure GaAs/GaAlAs ILD operating at 850nm has a cavity length of 500μm, and refractive index of the cavity is 3.7. How many longitudinal modes are emitted? What is the mode separation in terms of frequency (Hz) and wave length?

3 + (2 + 3) + 4 = 12

Group - D

6. (a) Explain the working principle of p - i - n Photo diode with a diagram.

(b) Prove that $R=\frac{\eta e\lambda}{hc}$ where, R = responsivity, e = electronic charge, h = plank's constant, λ = wavelength and c = velocity of light.

(c) A typical photodiode has a responsivity of $0.40AW^{-1}$ for a He-Ne laser source (λ = 632.8 nm). The active area of the photodiode is $2mm^2$. What will be the output photocurrent if the incident flux is 100 mw/mm^2.

4 + 5 + 3 = 12

7. (a) Explain the principle of operation of WDM with relevant block diagrams.