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
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> 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)   A step index fiber has a core refractive index 1.5 and cladding refractive index 1.46. Its numerical aperture is
   (a) 0.156   (b) 0.244   (c) 0.344   (d) 0.486.

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

   (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)   Light in a graded index fiber is guided by
   (a) Total Internal Reflection   (b) Refraction
   (c) Both (a) & (b)   (d) None

   (vi) Given that, *Ge* has a bandgap of 0.67 eV, what is the maximum wavelength that will be absorbed by it?
   (a) 7080 nm   (b) 4560 nm
   (c) 1850 nm   (d) 1100 nm.

   (vii) A p-n photodiode, on an average, generates one electro-hole pair per five incident photons at a wavelength of 900 nm. Assuming all the photo-generated electrons are collected, what is the quantum efficiency of the diode?
   (a) 20%   (b) 30%
   (c) 40%   (d) 50%.

(viii)   EDFA operates at the following windows
    (a) Around 1300 nm   (b) Around 1550 nm
    (c) Around 980 nm   (d) None.

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

(x)   SONET sends _____ number of frames per second.
    (a) 1000   (b) 2000
    (c) 4000   (d) 8000

Group – B

2.   (a)   What are the functions of core and cladding in an optical fiber?
                                              [(CO1)Remember/LOCQ]
    (b)   Explain how the multimode optical rays are propagated through the Graded-Index optical fiber with a suitable diagram.   [(CO1)(Analyse/IOCQ)]
    (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.
                                          [(CO1)(Evaluate/HOCQ)]
                                        (2 + 2) + 3 + 5 = 12

3.   (a)   Derive the expression for material dispersion in optical fiber.
                                          [(CO1)(Analyze/IOCQ)]
    (b)   Define bending loss and connector loss for optical fiber.
                                      [(CO1)(Remember/LOCQ]
    (c)   What are the causes of attenuation?   [(CO1)(Analyze/IOCQ)]
                                          4 + (2 + 2) + 4 = 12

Group – C

4.   (a)   Define Internal Quantum efficiency & External quantum efficiency of an LED.
                                        [(CO2)(Remember/LOCQ]
    (b)   With neat diagram, explain the operation of edge-emitting double hetero structure LED. Also mention its advantages over surface emitting double hetero structure.   [(CO2)(Analyze/IOCQ)]
                                        4 + (4 + 4) = 12

5.   (a)   What is population inversion? Find the threshold condition for lasing operation.
                                        [(CO2)(Remember/LOCQ)]
    (b)   Describe the operation of Injection LASER diode. What is index guiding?
                                      [(CO2)(Remember/LOCQ)]
                                        (3 + 3) + (4 + 2) = 12

Group – D

6. (a) Derive the relation between quantum efficiency and responsivity of a photodiode. [(CO3)Analyze/IOCQ)]
    (b) Discuss the operation of Avalanche photo detector with appropriate diagrams. [(CO3)(Analyze/IOCQ)]
    (c) An APD has a quantum efficiency of 75% at 900nm.When illuminated with optical power of 0.8 µW at this wavelength, it produces an output photocurrent of 10 µA. Calculate the multiplication factor of the diode. [(CO3)(Evaluate/HOCQ)]

    4 + 5 + 3 = 12

7. (a) Explain the principle of operation of WDM with relevant block diagrams. [(CO4)Remember/LOCQ)]
    (b) With the help of energy level diagram, explain the principle of operation of EDFA. [(CO4)Analyze/IOCQ)]

    5 + 7 = 12

Group - E

8. (a) What do you mean by SONET? Describe the different layers in SONET. [(CO4)(Remember/LOCQ)]
    (b) Explain the frame structure of SONET. [(CO4)(Analyze/IOCQ)]
    (c) Name different network topologies. [(CO4)(Remember/LOCQ)]

    (2 + 4) + 4 + 2 = 12

9. Write short notes on (Any Three): **(3 × 4) = 12**
    (i) Multimode Fiber
    (ii) Step index optical fiber.
    (iii) SOA
    (iv) FDDI. [(Remember/LOCQ)]

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	25	57	18

Course Outcomes (CO):

Students will come to know about:
1. Basics of optical fiber communication.
2. Different optical sources and the differences.
3. Types of optical detectors.
4. Optical networks and their comparison.