

OPTICAL FIBRE COMMUNICATION
(ECEN 4223)

Time Allotted : 2½ hrs

Full Marks : 60

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 4 (four) from Group B to E, taking one from each group.*

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

Group – A

1. Answer any twelve:

12 × 1 = 12

Choose the correct alternative for the following

- (i) The attenuation caused by Rayleigh scattering is proportional to
 - (a) $1/\lambda$
 - (b) $1/\lambda^3$
 - (c) $1/\lambda^4$
 - (d) $1/\lambda^6$
- (ii) In how many primary windows an optical fiber can operate?
 - (a) 2
 - (b) 3
 - (c) 1
 - (d) 4
- (iii) Which factor most affects the brightness of an LED?
 - (a) Voltage applied
 - (b) Current flowing through the LED
 - (c) Frequency of light
 - (d) Material type
- (iv) What type of emission process is used in a laser?
 - (a) Spontaneous emission
 - (b) Stimulated emission
 - (c) Thermal emission
 - (d) Radiative recombination
- (v) Which property of laser light allows it to be used in fiber optic communications?
 - (a) High power consumption
 - (b) Incoherence
 - (c) High divergence
 - (d) High coherence and monochromaticity
- (vi) A photoconducting detector can be constructed from
 - (a) an intrinsic semiconductor.
 - (b) an extrinsic semiconductor.
 - (c) polycrystalline material.
 - (d) all of these.
- (vii) EDFA operates at the following window/windows
 - (a) Low dispersion window(around 1.3 μm).
 - (b) Low attenuation window(around 1.55 μm).
 - (c) Both the windows.
 - (d) None of these.

- (viii) Which of the following describes an optical property of a photodiode?
 (a) The frequency at which its output reduces by 3 dB.
 (b) The gradient of its current voltage curve at zero bias.
 (c) A measure of the sensitivity to light.
 (d) The response speed of the photodiode to light signals.
- (ix) In SONET, which layer deals with the physical transmission of the signal?
 (a) Path Layer (b) Section Layer
 (c) Line Layer (d) Photonic Layer
- (x) Which of the following protocols is SONET most closely associated with?
 (a) Ethernet (b) MPLS
 (c) ATM (d) TDM

Fill in the blanks with the correct word

- (xi) _____ loss occurs when an optical fiber bends too sharply, causing some of the light to escape the core.
- (xii) The phenomenon that allows light to be guided through an optical fiber is called _____.
- (xiii) In optical fiber communication, the unit used to measure attenuation is _____.
- (xiv) _____ refers to the weakening of the optical signal as it travels through the fiber.
- (xv) Optical fibers can operate in three primary windows, the most commonly used window being around _____ nm due to low attenuation.

Group - B

2. (a) Differentiate between single mode optical fiber and multimode optical fiber. Derive the intermodal dispersion of multimode step index fiber. [[CO2](Analyse/IOCQ)]
- (b) A cylindrical step index fiber with a core diameter of 7.2 μm and a relative index difference of 1% is operating at a wavelength of 1.55 μm . If the core refractive index is 1.46, estimate: (i) the normalized frequency for the fiber (ii) the number of guided modes. [[CO6](Evaluate/HOCQ)]
- 6 + 6 = 12**
3. (a) Define bending loss and connector loss for optical fiber. [[CO2](Remember/LOCQ)]
- (b) Discuss different causes of attenuation in fiber. [[CO3](Analyse/IOCQ)]
- (c) With neat sketch discuss the propagation of optical signal through fiber. [[CO2](Remember/LOCQ)]
- 4 + 4 + 4 = 12**

Group - C

4. (a) With neat diagram, explain the operation of surface-emitting double hetero structure LED. Also mention its advantages. [[CO3](Apply/IOCQ)]

- (b) The power generated internally within a double-heterojunction LED is 28.4 mW at a drive current of 60 mA. Determine the peak emission wavelength from the device when the radiative and nonradiative recombination lifetimes of the minority carriers in the active region are equal. [[CO3](Analyse/HOCQ)]
7 + 5 = 12
5. (a) What is population inversion? Find the threshold condition for lasing operation [[CO1,CO3](Remember/LOC)]
 (b) Explain the operation principle of edge emitting laser and justify its advantages with suitable diagram. [[CO3] (Analyze/IOCQ)]
 (c) Estimate the mirror reflectivities needed in a GaAs-AlGaAs double heterostructure laser in which the fabry perot cavity length is 20μm and cavity loss is 10cm⁻¹. The optical confinement factor is unity and threshold gain in the medium is 10³cm⁻¹. [[CO6](Evaluate / HOCQ)]
5 + 3 + 4 = 12

Group - D

6. (a) Discuss the operation of *p-i-n* photo detector with appropriate diagrams. [[CO4](Analyze/IOCQ)]
 (b) Derive the relation between quantum efficiency and responsivity of a photodiode. Photons of wavelength 0.8 μm are incident on a p-n photodiode at a rate of $5 \times 10^{10} \text{ s}^{-1}$ and on average the electrons are collected at the terminals of the diode at the rate of $1.5 \times 10^{10} \text{ s}^{-1}$. Specify the quantum efficiency and responsivity of the photodiode. [[CO4](Analyze/IOCQ)]
5 + 7 = 12
7. (a) Explain major types of devices for multiplexing / demultiplexing. Compare their merits and demerits. [[CO3](Understand/LOCQ)]
 (b) Write a short note on optical amplifiers. [[CO4](Understand/LOCQ)]
6 + 6 = 12

Group - E

8. (a) Describe the differences between SONET and SDH in terms of their physical layer implementation. What are the key variations in terms of framing, data rates, and signal hierarchy? [[CO5] (Understand/LOCQ) (Analyze/HOCQ)]
 (b) Describe the process of multiplexing in SONET/SDH. How does the physical layer handle multiple lower-rate signals within a higher-rate signal? [[CO6] (Understand/LOCQ)]
6 + 6 = 12
9. (a) Illustrate the working of a Time Division Multiplexing (TDM) system in a PON. How does it manage multiple users? [[CO5](Analyze/HOCQ)]

- (b) What is the importance of the splitter in a PON network, and how does it affect network performance?

[(C05)(Remember/LOCQ)]

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	38.5	33.3	28.2