# FIBER OPTIC COMMUNICATION
## (ECEN 4142)

**Time Allotted : 2½ hrs**                                            **Full Marks : 60**

*Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and
<u>any 4 (four)</u> from Group B to E, taking <u>one</u> 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)     Light is guided within the core of a step-index fiber by
            (a) refraction at the core-air interface
            (b) total internal reflection at the core-cladding interface
            (c) total internal reflection at the outer surface of the cladding
            (d) change in the speed of light within the core.

    (ii)    In a step-index fiber, what is the cut-off frequency of the $LP_{11}$ mode?
            (a) 0.0            (b) 2.405            (c) 3.832            (d) 5.520.

    (iii)   Which of these converts the electrical signal to optical signals?
            (a) Optical photo detectors          (b) Demultiplexers
            (c) Multiplexers                     (d) Optical modulator.

    (iv)    Which of the following pairs are suitable for making a heterojunction?
            (a) Si and Ge                        (b) Si and GaAs
            (c) GaAs and AlAs                    (d) GaAs and GaAlAs.

    (v)     Which mechanism is used in Laser Technology for generation of light?
            (a) Dispersion                       (b) Absorption
            (c) Stimulated Emission              (d) Spontaneous Emission.

    (vi)    Optical splice provides a connection between
            (a) transmitter to fiber             (b) receiver to fiber
            (c) fiber to fiber                   (d) fiber to repeater.

    (vii)   A 1x 10 coupler has an input signal 0dBm. What is the power level at each output port?
            (a) 0dBm          (b) -1dBm          (c) -3dBm          (d) -10dBm.

    (viii)  Which of the following tunable filters is most suitable for DWDM?
            (a) Mach-Zehnder interferometer      (b) Fabry-Perot filters
            (c) Acousto-optic tunable filters    (d) Fiber Bragg gratings.

(ix)   Gain in EDFA depends on the following factors
(a) Doping concentration          (b) Length of the doped fiber
(c) Pump power                    (d) All of these.

(x)    The essential condition for total internal reflection to take place within the optical fiber is when the incidence angle exceeds the specified value of
(a) Critical angle                (b) Refraction angle
(c) Reflection angle              (d) Acceptance angle.

*Fill in the blanks with the correct word*

(xi)   _____ detectors give amplified output.

(xii)  Dispersion is maximum in _____ type of optical fibers.

(xiii) Unlike wired media, optical fibers are highly resistant to_____.

(xiv)  The attenuation caused by Rayleigh scattering is proportional to___.

(xv)   _____ Type of fiber that has the highest modal dispersion.

# Group - B

2.  (a)   A step-indexed fiber has a core and cladding refractive indices of 1.48 & 1.46 respectively and supports an optical signal of 820 nm. Calculate the core radius & NA for a single mode fiber.          *[(CO1,CO2,CO6)(Evaluate/HOCQ)]*

    (b)   Define Acceptance angle and Numerical Aperture. Derive expressions for acceptance angle & numerical aperture, highlighting their relationship.
    *[(CO1,CO2)(Understand/LOCQ)(Apply/IOCQ)]]*

    (c)   Why optical communication is preferred over other conventional electrical Communication?          *[(CO1)(Remember/LOCQ)]*

    **4 + (1 + 1 + 2) + 4 = 12**

3.  (a)   Differentiate between single mode optical fiber and multimode optical fiber.
    *[(CO1,CO2)(Analyse/IOCQ)]*

    (b)   Derive the intermodal dispersion of multimode step index fiber.
    *[(CO1,CO2)(Evaluate/HOCQ)]*

    (c)   Explain the different causes of attenuation in optical fiber.          *[(CO3)(Analyse/IOCQ)]*

    **4 + 4 + 4 = 12**

# Group - C

4.  (a)   Explain with example the direct band gap and indirect band gap type semiconductors? Which of these are more suitable for fabricating LEDs? Give reasons.          *[(CO3)(Remember/LOCQ)]*

    (b)   What are homojunctions and heterojunctions properties?          *[(CO3)(Remember/LOCQ)]*

    (c)   Consider a GaAs p-n junction in equilibrium at room temperature (RT = 300K). Assume that the acceptor and donor impurity concentrations are $5 \times 10^{23} m^{-3}$ and $5 \times 10^{21} m^{-3}$, respectively. Calculate the diffusion potential $V_D$.          *[(CO6)(Evaluation/HOCQ)]*

    **(2 + 2) + 3 + 5 = 12**

5.  (a)  Illustrate the principles of fiber optic coupler & Splitters.  *[(CO4)(Apply/IOCQ)]*
    (b)  Write, how to Test the Quality of Fiber Optic Splitter?  *[(CO4)(Synthesis/HOCQ)]*
    (c)  Describe briefly the Characteristics of Light Source of Communication in connection of fiber optics communication.  *[(CO5)(Knowledge/LOCQ)]*

    **(2 + 2) + 4 + 4 = 12**

# Group - D

6.  (a)  Describe the working principle of avalanche photo detector.  *[(CO4)(Analyse/IOCQ)]*
    (b)  Define responsivity and efficiency of a photo detector.  *[(CO4)(Remember/LOCQ)]*
    (c)  Compare the merits of avalanche photodiode and photo conducting detector in respect of optical communication.  *[(CO4)(Analyse/IOCQ)]*

    **4 + (2 + 2) + 4 = 12**

7.  (a)  Illustrate the basic principle of operation of semiconductor optical amplifier (SOA).  *[(CO4)(Apply/IOCQ)]*
    (b)  Distinguish between the amplification process in an erbium doped fiber amplifier and a fiber Raman amplifier.  *[(CO4)(Remember/LOCQ)]*
    (c)  What is electro optic effect?  *[(CO4)(Remember/LOCQ)]*

    **4 + 6 + 2 = 12**

# Group - E

8.  (a)  Compare the LAN, MAN & WAN.  *[(CO5)(Analyse/IOCQ)]*
    (b)  Discuss with some examples of sociological needs in rural areas, which are best met by ISDN?  *[(CO5)(Analyse/IOCQ)]*

    **6 + 6 = 12**

9.  (a)  Discuss with necessary block diagram about Synchronous Optical Network (SONET).  *[(CO5)(Analyse/IOCQ)]*
    (b)  Describe briefly about the high speed Ethernets.  *[(CO4)(Remember/LOCQ)]*
    (c)  State the different type of Network Topologies.  *[(CO5)(Remember/LOCQ)]*

    **4 + 4 + 4 = 12**

| Cognition Level | LOCQ | IOCQ | HOCQ |
|---|---|---|---|
| Percentage distribution | 36.46 | 45.83 | 17.71 |

**Course Outcome (CO):**

After the completion of the course students will be able to
1.  Apply the basic idea of electronics, physics and solid state devices and explain the operation of different components in an optical communication system.
2.  Understand the properties of optical fiber and categorize the transmission characteristics of a wave through the optical fiber.
3.  Analyze the structure of various optical sources and can classify them according to the performance, efficiency and application.
4.  Explain the operation of optical detectors and can analyze the performance parameters of a detector. 5. Recognize the current optical technologies used for long distance communication and their application in optical networks.
6.  Solve the problems related to optical fiber communication and can justify the physical significance of the solutions.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.*