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**Seventh Semester B.E. Degree Examination, Jan./Feb. 2021**  
**Optical Fiber Communication**

Time: 3 hrs.

Max. Marks: 100

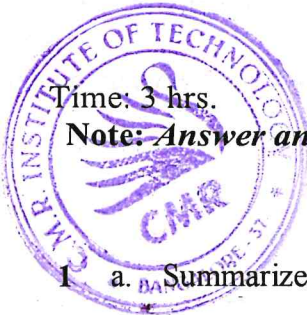
**Note:** Answer any FIVE full questions, selecting atleast TWO questions from each part.

**PART – A**

1.
  - a. Summarize the inherent advantages of optical fiber over conventional copper cables. (06 Marks)
  - b. Describe with neat diagram different types of optical fiber waveguides. Using ray theory, explain the propagation of light inside the fiber. (08 Marks)
  - c. A silica optical fiber with a core diameter large enough to be considered by ray theory analysis has a core refractive index of 1.5. A light ray is incident at the core-cladding interface with a critical angle of  $78.5^\circ$ . Estimate:
    - i) Refractive index of cladding
    - ii) Numerical aperture
    - iii) The acceptance angle in air for the fiber (06 Marks)
2.
  - a. Explain the different types of absorption losses in optical fiber. (06 Marks)
  - b. Derive an expression for pulse spreading due to material dispersion which is a function of wavelength and time delay. (08 Marks)
  - c. Explain the different types of bending losses in optical fiber. (06 Marks)
3.
  - a. Draw and explain the cross-sectional view of a typical AlGaAs double heterojunction LED, along with the energy diagram. (08 Marks)
  - b. Sketch and explain the GaAs homojunction injection laser with a Fabry-Perot cavity. (06 Marks)
  - c. A planar LED is fabricated from Gallium Arsenide which has a refractive index of 3.6,
    - i) Calculate the optical power emitted into air as a percentage of the internal optical power for the device when the transmission factor at the crystal-air interface is 0.68.
    - ii) When the optical power generated internally is 50% of the electric power, determine the external power efficiency. (06 Marks)
4.
  - a. Show that optical power coupled into a step index fiber due to an LED with lambertian distribution is given by  $P = P_s (NA)^2$  for  $r_s \leq a$ , with usual notations. (07 Marks)
  - b. What are different types of mechanical misalignments? (05 Marks)
  - c. Explain briefly the various fiber splicing techniques. (08 Marks)

**PART – B**

5.
  - a. Draw the signal path through an optical digital link showing all the relevant waveforms. (06 Marks)
  - b. Draw and explain the two general heterodyne receiver configurations, along with the relevant expressions for BER. (08 Marks)
  - c. Draw and explain the two types of front end amplifiers in optical fiber communication. (06 Marks)



- 6 a. Draw the block diagram, and explain the multichannel amplitude modulation technique used in fiber optics. (08 Marks)
- b. Explain the significance of link power budget and system margin. The following optical link parameters are given :
- |                                  |             |
|----------------------------------|-------------|
| Optical power launched           | = 6 dBm     |
| Receiver sensitivity             | = -25 dBm   |
| Source 1 detector connector loss | = 1 dB      |
| Fiber cable length               | = 100 km    |
| Cable attenuation                | = 0.1 dB/km |
| Jumper cable loss                | = 3 dB      |
| Connector loss at each joint     | = 1dB       |
- Assume two jumper cables and two cable joints. Compute link power margin. (06 Marks)
- c. Derive the total system rise time expression for a digital optical link. (06 Marks)
- 7 a. Describe the operational principles of WDM, depicting the implementation of a typical WDM network containing various types of optical amplifier. (08 Marks)
- b. With a neat diagram, explain the working principle of Mach-Zehnder inter-ferometer multiplexer. (08 Marks)
- c. The input wavelengths of a  $2 \times 2$  silicon Mach-Zehnder inter ferometer are separated by 10 GHz. The effective refractive index in the waveguide is 1.5. Calculate waveguide length difference. (04 Marks)
- 8 a. Explain in detail the amplification mechanism with energy level diagram in an EDFA. (10 Marks)
- b. With suitable diagram describe SONET/SDH optical network function. (10 Marks)

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