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Sub Code: EEC-049(A)

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**B.TECH**  
**(SEM. VII) THEORY EXAMINATION 2017-18**  
**OPTICAL FIBER COMMUNICATION**

*Time: 3 Hours**Total Marks: 100*

- Note:** 1. Attempt all Sections.  
 2. Assume any missing data.

**SECTION A**

- 1. Attempt all questions in brief. 2 x 10 = 20**
- a. List the properties of optical fiber that results in signal degradation.
  - b. What is core and cladding in optical fiber?
  - c. A silica optical fiber with a core refractive index of 1.50 and a cladding refractive index of 1.47. Determine the numerical aperture for the fiber.
  - d. How does quantum noise arise?
  - e. What is mode coupling?
  - f. What is insertion loss?
  - g. What is threshold current density of LASER?
  - h. What is dark current?
  - i. Differentiate between single mode fiber and multi mode fiber.
  - j. Mention the noise present in optical receiver.

**SECTION B**

- 2. Attempt any three of the following: 10 x 3 = 30**
- a. What is phase velocity & group velocity? Derive the relation between group velocity & group index of the guide.
  - b. Describe the hetro junction in LED diode and also write short notes on noise source on optical fiber communication.
  - c. A photodiode has a quantum efficiency of 65% when photon of energy  $1.5 \times 10^{19} \text{J}$  is incident upon it. Calculate (i) The operating wavelength of photodiode (ii) The incident optical power required to obtain a photocurrent of  $1.5 \mu\text{A}$ .
  - d. Describe linear scattering losses in optical fiber with regard to: Rayleigh scattering. & Mie scattering.
  - e. Describe with the aid of suitable diagrams the mechanism giving the emission of light from an LED. Discuss the effects of this mechanism on the properties of the LED in relation to its use as an optical source for communications.

**SECTION C**

- 3. Attempt any one parts of the following: 10 x 1 = 10**
- a) Explain in detail:
    - (i). Pulse broadening.
    - (ii). Modal birefringence.
  - b) Define the normalized frequency for an optical fiber and explain its use in the determination of the number of guided modes propagating within a step index fiber.

A step index fiber in air has a numerical aperture of 0.16, a core refractive index of 1.45 and a core diameter of  $60 \mu\text{m}$ . Determine the normalized frequency for the fiber when light at a wavelength of  $0.9 \mu\text{m}$  is transmitted. Further, estimate the number of guided modes propagating in the fiber.

**4. Attempt any one parts of the following:****10 x 1 = 10**

- a) Discuss absorption losses in optical fibers, comparing and contrasting the intrinsic and extrinsic absorption mechanisms.

A 15 Km optical fiber link uses fiber with a loss of  $1.5 \text{ dB Km}^{-1}$ . The fiber is jointed every kilometer with connectors which give an attenuation of 0.8 dB each. Determine the minimum mean optical power which must be launched into the fiber in order to maintain a mean optical power level of  $0.3 \mu\text{m}$  at the detector.

- b) Define absorption, spontaneous emission and stimulated emission and derive the Einstein relations for the same.

**5. Attempt any one parts of the following:****10 x 1 = 10**

- a) Explain the principle, construction and working of semiconductor injection laser diode. Explain the phenomenon of Mode hopping and frequency chirping in the injection laser.

- b) What is the significance of intrinsic layer in PIN diode? What is the principle of working of PIN diode? Also explain the factor that limit the speed response of photodiodes

**6. Attempt any one parts of the following:****10 x 1 = 10**

- a) Define the quantum efficiency and the responsivity of a photodetector. Derive an expression for the responsivity of an intrinsic photodetector in terms of the quantum efficiency of the device and the wavelength of the incident radiation. Determine the wavelength at which the quantum efficiency and the responsivity are equal.

- b) Discuss the operation of the silicon RAPD, describing how it differs from the p-i-n photodiode. Outline the advantages and drawbacks with the use of the RAPD as a detector for optical fiber communications.

**7. Attempt any one parts of the following:****10 x 1 = 10**

- a) Explain the following:

(i). Critical angle.

(ii). Acceptance angle.

(iii). Numerical aperture

- b) Discuss subcarrier intensity modulation using amplitude and frequency modulation.