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Question Paper Code : 10545

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2025.

Seventh Semester

Electrical and Communication Engineering

EC 8751 – OPTICAL COMMUNICATION

(Common to : Computer and Communication Engineering)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the conditions for total internal reflection?

2. Why is step index single mode fiber preferred for long distance communications?

3. What are the factors that cause Rayleigh scattering in optical fibers?

4. What are the two reasons for chromatic dispersion?

5. What do you mean by hetero junction? Mention its advantages.

6. Define External quantum efficiency.

7. What are the desired features of a photo detector?

8. List the benefits and drawbacks of avalanche photodiodes.

9. What is the purpose of rise-time budget analysis?

10. List out the benefits of SONET over PDH networks.

PART B — ($5 \times 13 = 65$ marks)

11. (a) The velocity of light in the core of a step index fiber is 2.01×10^8 ms^{-1} and the critical angle at the core–cladding interface is 80°. Determine the numerical aperture and the acceptance angle for the fiber in air, assuming it has a core diameter suitable for consideration by ray analysis. The velocity of light in a vacuum is 2.998* 10^3 ms^{-1}.

Or

(b) A single-mode step index fiber which is designed for operation at a wavelength of 1.3 μm has core and cladding refractive indices of 1.447 and 1.442 respectively. When the core diameter is 7.2 μm, confirm that the fiber will permit single-mode transmission and estimate the range of wavelengths over which this will occur.

12. (a) The threshold optical power for stimulated Brillouin scatting at a wavelength of 0.85μm in a long single-mode fiber using an injection laser source with a bandwidth of 800 MHz is 127 mW. The fiber has an attenuation of 2 dB km^{-1} at this wavelength. Determine the threshold optical power for stimulated Raman scattering within the fiber at a wavelength of 0.9 μm assuming the fiber attenuation is reduced to 1.8 dB km^{-1} at this wavelength.

Or

(b) An 8 km optical fiber link without repeaters uses multimode grated index fiber which has a bandwidth-length product of 400 MHz km. Estimate:

(i) The total pulse broadening on the link; (7)

(ii) The rms pulse broadening on the link. (6)

It may be assumed that a return to zero code is used.

13. (a) The external power efficiency of an InGaAsP/InP planar LED is 0.75% when the internally generated optical power is 30 mW. Determine the transmission factor for the InP-air interface if the drive current is 37 mA and the potential difference across the device is 1.6 V. The refractive index of InP may be taken as 3.46.

Or

(b) Given that the following measurements were taken for an APD, calculate the multiplication factor for the device.

Received optical power at 1.35 μm = 0.2 μW

Corresponding output photocurrent = 4.9 μA

(after avalanche gain)

Quantum efficiency at 1.35 μm = 40%

14. (a) Comment any two simple techniques used for the measurement of the numerical aperture of optical fibers.

Or

(b) Pulse dispersion measurements are taken on a multimode graded index fiber in the time domain. The 3 dB width of the optical output pulses from a 950 m fiber length is 827 Ps. When the fiber is cut back to a 2 m length the 3 dB width of the optical output pulses becomes 234 ps. Determine the optical bandwidth for a kilometre length of the fiber assuming Gaussian pulse shapes.

15. (a) An optical system has the following characteristics:

LED power (Ps) = 2 mW (3 dBm)

LED to fiber loss (Lsf) = 3 dB

Fiber loss per km (FL) = 0.5 dB/km

Fiber length (L) = 40 km

Connector loss ($Lconn$) = 1 dB (one connector between two 20-km fiber lengths)

Fiber to detector loss (Lfd) = 3dB

Receiver sensitivity (Pr) = —36 dBm

Find the loss margin.

Or

(b) Which sublayer within the SONET or optical layer would be responsible for handling the following functions? Give the valid reasons

(i) A SONET path fails, and the traffic must be switched over to another path. (5)

(ii) Many SONET streams are to be multiplexed onto a higher-speed stream and transmitted over a SONET link. (4)

(iii) A fiber fails, and SONET line terminals at the end of the link reroute all the traffic on the failed fiber onto another fiber. (4)

PART C — (1 × 15 = 15 marks)

16. (a) A digital single mode optical fiber system is designed for operation at a wavelength of 1. 5 μm and transmission rate of 560 Mbit s^{-1} over a distance of 50 km without repeaters. The single mode injection laser is capable of launching a mean optical power of –13 dBm into the fiber cable which exhibits a loss of 0.35 dB km^{-1}. In addition, average splice losses are 0.2 dB at 1 km intervals. The connector loss at the receiver is 0,6 dB and the receiver sensitivity is–39 dBm. Finally, an extinction ratio penalty of 1 dB is predicted for the system. Perform an optical power budget for the system and determine the safety margin.

Or

(b) Present the concept and working of edge light emitting diode with necessary diagrams and expressions.

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