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10EC/TE72

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° . 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)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg. $42+8=50$, will be treated as malpractice.



- 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 2×2 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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