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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 incidented 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 lambartian 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 jumber 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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