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10EC72

Seventh Semester B.E. Degree Examination, June/July 2017

Optical Fiber Communication

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least 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. Illustrate the different types of scattering losses in optical fiber with suitable equations. **(08 Marks)**

b. Explain what is meant by the critical bending radius for an optical fiber. Write equation of critical radius of curvature for multimode and single mode fibers. **(06 Marks)**

c. A multimode fiber with a core refractive index of 1.5, a relative refractive index difference of 3% and an operating wavelength of 0.82 μm. Estimate the critical radius of curvature at which large bending losses occur. **(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. With the aid of simple sketches, outline optical fiber coupler types and their functions. **(08 Marks)**

b. Discuss different types of fiber misalignment and the factors which causes the losses due to those misalignment. **(06 Marks)**

c. A single mode fiber has the following parameters:
Normalised frequency (V) = 2.40
Core refractive index (n_1) = 1.46
Core diameter (2a) = 8μm
Numerical aperture (NA) = 0.1
Normalised spot size (ω) = 3.12 μm.
Estimate the total insertion loss of a fiber joint with a lateral misalignment (Y) of 1 μm and an angular misalignment (θ) of 1°. **(06 Marks)**

PART – B

5 a. Briefly explain the quantum limit. **(04 Marks)**

b. What is a Burst_Mode receiver? Explain. **(06 Marks)**

c. Derive the equation for performance fidelity of an analog receiver. Substantiate that for a large optical signals, signal to noise ratio represents the quantum limit for receiver sensitivity. **(10 Marks)**

6 a. With a diagram, briefly explain the operation of multichannel amplitude modulation. **(08 Marks)**

b. Explain the radio frequency over fiber concept of a broadband wireless access network for interconnecting antenna base stations with the central controlling office. **(08 Marks)**

c. In a multimode link using LED as optical source, material dispersion related rise time degradation is 21 ns over the 6 km link. Receiver has a 25 MHz bandwidth. Fiber has 500 MHz.km bandwidth-distance product with mode mixing parameter, q = 0.7. Assuming LED with drive circuit has rise time of 15 ns, modal-dispersion-induced fiber rise time is 3.9 ns and the contribution to the rise-time degradation from the receiver is 14 ns. Calculate link rise time. **(04 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 with the aid of neat diagram, three possible EDFA configurations. **(06 Marks)**

b. Describe:

i) SONET/SDH frame format

ii) SONET/SDH rings **(10 Marks)**

c. An EDFA is pumped at 980 nm with a 30 mW pump power. If the gain at 1550 nm is 20 dB, calculate maximum input power. **(04 Marks)**

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