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06EC72

Seventh Semester B.E. Degree Examination, Dec.2014/Jan.2015

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. With the help of a block diagram, explain the main constituents of an optical fiber communication link. **(08 Marks)**

b. Define the terms: i) acceptance angle, ii) numerical aperture. Derive expressions for maximum acceptance angle and numerical aperture highlighting their relationship. **(08 Marks)**

c. A step index fiber has a core and cladding refractive indices of 1.48 and 1.46 respectively and supports propagation of an optical signal of wavelength 820 nm. Calculate core radius, numerical aperture and acceptance angle for a single mode fiber. **(04 Marks)**

2 a. Discuss briefly various attenuation mechanisms in an optical fiber. **(09 Marks)**

b. What are intromodal dispersion and inter modal dispersion? **(06 Marks)**

c. An CED operating at 850 nm has a spectral width of 45 nm. What is the pulse spreading in ns/km due to material dispersion? **(05 Marks)**

3 a. With the help of a schematic diagram, explain the design features of an edge emitting LED. **(06 Marks)**

b. Define the terms:
i) Spontaneous emission
ii) Stimulated emission
iii) Quantum efficiency. **(03 Marks)**

c. With the help of a schematic diagram, explain briefly construction and operation of RAPD. **(06 Marks)**

d. An InGaAs PIN diode operating at a wavelength of 1300 nm has the following specification:
i) Quantum efficiency = 90%
ii) Dark current ID = 4 nA
iii) Load resistor RL = 1 KΩ
iv) Incident optical power = 300 nW
v) Receiver bandwidth = 200 MHz
Assuming negligible surface leakage current, calculate the mean square value of shot noise, dark current noise and thermal noise currents. **(05 Marks)**

4 a. Show that $P_{LED\ step} = P_s (NA)^2$ for $r \leq a$ with usual notations. **(08 Marks)**

b. Explain briefly the principle of operation of the following:
i) Expanded beam connectors
ii) Fiber fused biconical taper coupler **(08 Marks)**

c. Consider a LED with a circular emitting area of radius 36μm and a Lambertian Gaussian pattern of 151 Watts. Compare the optical power coupled into following two types of step index fibers:
i) SIF with a core radius of 26 μm (NA = 0.2)
ii) SIF with a core radius of 51 μm (NA = 0.2) **(04 Marks)**

PART – B

5 a. With the help of a signal flow diagram, explain briefly the operation of a digital transmission link as an optical data link with waveforms at each stage. **(08 Marks)**

b. Write short notes on the following:
i) FET based high impedance amplifier
ii) Noise sources in optical receiver
iii) Burst mode receiver **(12 Marks)**

6 a. Derive an expression for carrier to noise ratio (CNR) of an analog optical fiber communication system under limiting conditions of noise sources involved. **(10 Marks)**

b. Write short notes on the following:
i) Rise tile budget
ii) Link power budget **(06 Marks)**

c. Calculate system rise time for a multimode optical fiber link with the following parameters:
i) LED with a drive circuit having rise time of 15 ns.
ii) LED spectral width 540 nm.
iii) Material dispersion related rise time 21 ns over a 6 km long link.
iv) Receiver bandwidth 25 MHz.
v) Modal dispersion rise time 3.9 ns. **(04 Marks)**

7 a. Define the following terms with relevant formulae:
i) Excess loss
ii) Return loss
iii) Insertion loss
with reference to 2 × 2 fused fiber coupler. **(08 Marks)**

b. What is WDM? How it is implemented in an OFC system? **(06 Marks)**

c. Write short notes on any two of the following:
i) 8 × 8 star coupler
ii) optical isolators
iii) optical circulators
iv) optical add/drop multiplexers **(06 Marks)**

8 a. Describe working of an EDFA. **(06 Marks)**

b. List out the basic applications of optical amplifiers and describe briefly with the different configurations. **(04 Marks)**

c. Write short notes on the following:
i) SONET/SDH rings
ii) Semiconductor optical amplifiers. **(10 Marks)**

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