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EC82

Eighth Semester B.E. Degree Examination, May / June 08
Optical Fiber Communications

Time: 3 hrs. Max. Marks:100

Note : ***Answer any FIVE full questions.***

1 a. Compare and contrast : i) Single mode v/s Multimode fibers. ii) Step – index v/s Graded index fibers. **(06 Marks)**

b. Discuss the necessary mathematical condition that the angle of incidence θ must satisfy for the optical rays to propagate in a dielectric slab wave-guide. **(08 Marks)**

c. A multimode step – index fiber with a core diameter of 80μm and a refractive index difference of 1.5% is operating at a wave length of 0.85μm. If the core refractive index is 1.48, estimate the normalized frequency for the fiber and the number of guided modes. **(06 Marks)**

2 a. Explain the three different mechanisms that cause absorption of optical energy in optical fibers. **(06 Marks)**

b. Explain the contributions of microscopic and macroscopic fiber bends towards the bending losses in optical fibers. **(06 Marks)**

c. Describe the material dispersion and wave guide dispersion. **(08 Marks)**

3 a. Draw the diagram of a typical GaAlAs double hetero-structure light emitter along with energy band diagram and refractive index profile and explain. **(10 Marks)**

b. Sketch and explain the Fabry – Perot resonator cavity of laser. **(10 Marks)**

4 a. An LED has a circular emitting area of radius 35μm and a Lambersian pattern with 1.50 W/cm^2 steradian of axial brightness for a given drive current. Out of two step index fibers used, one has core radius 25μm and NA = 0.20 and the other has core radius 50μm and NA = 0.20. Calculate the power coupled to each fiber from the LED and compare. **(06 Marks)**

b. Explain with the diagrams, the different lensing schemes used to improve source – to – fiber coupling efficiency. **(06 Marks)**

c. Explain any five design requirements of a good optical fiber connector and highlight its alignment schemes used during connection. **(08 Marks)**

5 a. Discuss with a neat diagram, how digital signal transmission takes place in a fiber transmission link. **(12 Marks)**

b. What are the noise sources and disturbances that arise in optical pulse detection mechanism? Describe. **(08 Marks)**

6 a. In order to design a simplex point-to-point link, what are all the choices available with regard to the components and their associated characteristics? Discuss. **(10 Marks)**

b. Draw the optical power loss model diagram for a point-to-point link and explain the concept of link power budget. **(06 Marks)**

c. Explain briefly the NRZ codes and RZ codes used in line coding. **(04 Marks)**

7 a. Draw the block diagram of basic elements of an analog link and explain. **(10 Marks)**

b. How is frequency division multiplexing adopted for multi channel amplitude modulation? Discuss with the help of a diagram. **(10 Marks)**

8 a. Write the frame structure of SDH. How do you get a basic data rate of 155.54 mbps for STM – 1? What is PDH? **(10 Marks)**

b. Draw the diagram of a passive linear – bus coupler and discuss the losses encountered. **(10 Marks)**

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EC82

2002 SCHEME

~~Eighth~~ Semester B.E. Degree Examination, Dec.08/Jan.09
Optical Fiber Communication

Time: 3 hrs. Max. Marks:100

Note : ***1. Answer any FIVE full questions.***

1 a. What are the advantages and disadvantages of multimode and single-mode fibers? **(06 Marks)**

b. A step index fiber has a normalized frequency V=29.9 at 1350 nm wavelength. If the core radius is 35 μm, find the numerical aperture. **(04 Marks)**

c. Describe outside vapor phase oxidation method to prepare preform. **(06 Marks)**

d. What is mode-field diameter of single-mode fiber? **(04 Marks)**

2 a. Explain the effect of material and wavelength dispersions on pulse spreading. **(06 Marks)**

b. Optical power launched into fiber at transmitter end is 150 μw. The power at the end of 10 Km length of the link working in first window is –38.2 dBm. Another system of same length working in second window is 47.5 μw. Same length system working in third window has 50% of launched power. Calculate fiber attenuation for each case and mention wavelength of operation. **(04 Marks)**

c. Explain absorption mechanisms in optical fibers. **(05 Marks)**

d. What is design optimization in a single-mode fiber? **(05 Marks)**

3 a. With a neat diagram of cross-section of typical Ga AC As double-hetero structure LED, explain the structure and operation of the device. **(05 Marks)**

b. Explain the principle of laser action. Briefly explain the structure of VCSEL single-mode laser with a neat diagram. **(05 Marks)**

c. A Ga As laser operating at 1300nm has a 400 μm length and a refractive index n=3.5 What are the frequency and wavelength spacings? **(04 Marks)**

d. What are the different noise sources in a photodiode? **(06 Marks)**

4 a. Describe the emission patterns of different types of LED and laser diode. **(04 Marks)**

b. What are different types of mechanical misalignments? Compare their relative losses. **(06 Marks)**

c. Consider an LED that has a circular emitting area of radius 40 μm and a lambertian emission pattern with 100W/(cm^2.sr) axial radiance at a given drive current. What is the optical power coupled into step-index fiber having core radius of 30 μm with NA=0.22 ? **(05 Marks)**

d. Explain with neat diagram working of butt-joint and expanded beam optical connectors. **(05 Marks)**

5 a. Discuss how carrier-to-noise ratio changes with power level in an analog optical receiver. **(05 Marks)**

b. Derive an expression fro BER in a digital receiver. **(10 Marks)**

c. What is RIN and how does it vary with bias current of laser diode? **(05 Marks)**

6 a. What is graphical representation of a link-loss budget? **(06 Marks)**

b. Discuss transmission distance limits of a first window repeaterless digital link. **(08 Marks)**

c. A typical LED has spectral width of 40 nm, average value of dispersion 0.07 ns/(nm.Km), link length 6 Km, bandwidth 400Mhz.Km and mode mixing parameter q=0.7 Calculate t_{mat} and t_{mod}. **(06 Marks)**

7 a. Explain the operational principle and implementation of WDM. **(07 Marks)**

b. Describe 2 X 2 fiber couples and its various losses. **(08 Marks)**

c. What are four possible application of optical amplifier? **(05 Marks)**

8. Write short notes on:

a. Avalanche Photodiode

b. Wavelength –routed networks.

c. SONET/SDH standards.

d. Fiber optic cables. **(20 Marks)**

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06EC72

Seventh Semester B.E. Degree Examination, Dec.09/Jan.10
Optical Fibre Communication

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. What are the advantages, applications and disadvantages of optical fibre as compared to copper cables? **(08 Marks)**

b. Derive the numerical aperture of a step index fiber (SIF) from Snell's law. **(06 Marks)**

c. A multimode SIF has V number of 75, NA = 0.3, R.I. of core is 1.458 and operates at 820nm. Find core radius, R.I. of cladding, fractional change in R.I. and number of modes gets propagated. **(06 Marks)**

2 a. A 30 km long fiber at 1300 nm has an attenuation of 0.8 dB/km. If 200 μw power is launched into the fiber, find the output power in dBm and in watts. **(06 Marks)**

b. Briefly explain, different mechanisms which cause absorption losses in optical fibers. **(06 Marks)**

c. Derive an expression for pulse spreading and dispersion, which is a function of wavelength, using time delay. **(08 Marks)**

3 a. Draw the diagram of a typical GaAlAs double hetero structure LED, along with energy band diagram and refractive index profile and explain. **(08 Marks)**

b. Sketch and explain the Fabry-Perot resonator cavity of laser. **(06 Marks)**

c. A photodiode has a quantum efficiency of 65%, when photons of energy 1.5×10^{-19} Joules are incident upon it.
i) At what wavelength is the photodiode operating?
ii) Calculate the incident optical power required, to obtain a photocurrent of 2.5μA. **(06 Marks)**

4 a. A silica multimode step index fiber has a core refractive index of 1.46. Determine the optical loss in decibels due to Fresnel reflection at a fiber joint with:
i) A small air gap, ii) an index matching epoxy which has a refractive index of 1.40.
It may be assumed that the fiber axes and end faces are perfectly aligned at the joint. **(06 Marks)**

b. Explain different types of fiber splicing techniques. **(06 Marks)**

c. Briefly describe the principle of operation of the following:
i) Expanded beam connectors
ii) Fiber fused biconical taper coupler. **(08 Marks)**

PART – B

5 a. With a schematic diagram, explain the working of an optical receiver. **(06 Marks)**

b. What are the noise sources and disturbances that arise in optical pulse detection mechanism? Explain. **(08 Marks)**

c. Write a note on Burst-mode receivers. **(06 Marks)**

6 a. Explain multichannel A.M. technique employed in broadband analog applications. **(05 Marks)**

b. What is RF-over-fiber technique? Explain. **(05 Marks)**

c. What is rise time budget analysis? Derive an expression for the total system rise time budget in terms of transmitter fiber and receiver rise time. **(10 Marks)**

7 a. What is WDM? How is it implemented? **(05 Marks)**

b. Explain the design and operation of a polarization independent isolator. **(05 Marks)**

c. Explain the importance of the following active components used in WDM based on MEMS.
   i) Variable optical attenuators
   ii) Tunable optical filters. **(10 Marks)**

8 a. What are the applications of optical amplifiers? **(04 Marks)**

b. An EDFA is pumping 28mw of pump power at 970nm. If the gain at 1570 nm is 30 dB, determine maximum input and output signal power and also determine power conversion efficiency. **(06 Marks)**

c. Describe
   i) SONET/SDH frame formats
   ii) SONET/SDH Rings **(10 Marks)**

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06EC72

Seventh Semester B.E. Degree Examination, May/June 2010
Optical Fiber Communication

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Discuss the advantages of optical fiber communication. **(06 Marks)**

b. Derive the necessary mathematical condition that the angle of incidence θ must satisfy for the optical skew ray to propagate in a step index fiber. **(08 Marks)**

c. Estimate the maximum core diameter for an optical fiber with refractive index difference of 1.45% and core refractive index of 1.52 in order that it may be suitable for single-mode operation when operating wavelength is 0.85 μm. Also calculate cut off wavelength λ_c if core diameter is 1.1 μm. **(06 Marks)**

2 a. Explain material absorption losses of optical energy in silica glass fibers roughly sketching their contribution at different wavelengths. **(06 Marks)**

b. Explain what is material dispersion. Derive an expression for material dispersion starting from the expression for group delay. **(08 Marks)**

c. An 8 km optical link consists of multimode step index fibre with a core refractive index of 1.45 and relative index difference of 1.2%. Estimate :

i) The delay difference between the slowest and fastest modes at the fiber output

ii) The rms pulse broadening due to intermodal dispersion. **(06 Marks)**

3 a. Draw the cross-section of Ga Al As double-hetero structure LED, energy band diagram and refractive index variation. Explain their importance. **(07 Marks)**

b. Sketch and explain the Fabry-Perot resonator cavity of a laser diode. **(07 Marks)**

c. A GaAs laser operating at 850 nm has 450 μm length and refractive index $\eta = 3.5$. What are the frequency and wavelength spacing? If the half power point, $\lambda - \lambda_o = 2.5$ nm, what is the spectral width σ of the gain? **(06 Marks)**

4 a. Describe the different types of mechanical misalignments while joining two similar fibers. Compare their relative losses. **(05 Marks)**

b. Explain different mechanical splicing methods. **(06 Marks)**

c. Explain with a neat diagram the design of a basic ferrule connector. **(05 Marks)**

d. A four port multimode fiber FBT coupler has 50 μw optical power launched into port 1. Measured output at ports 2, 3 and 4 are 0.004, 26.0 and 27.5 μw respectively. (Ports 1 and 4 are input and output of one fiber and ports 2 and 3 are input and output of another fiber respectively). Calculate insertion losses and cross-talk. **(04 Marks)**

PART – B

5 a. Draw the signal path through a digital link with relevant components and optical/electrical waveforms at every stage. **(06 Marks)**

b. Explain with a neat diagram the fundamental concept of coherent detection. **(08 Marks)**

c. What is a burst – mode receiver? Explain. **(06 Marks)**

6 a. Following are the parameters of a point-to-point optical link:

i) Optical power launched : +5 dBm
ii) Sensitivity of detector : -30 dBm
iii) Source/detector connector loss : 1 dB
iv) Length of optical cable : 55 km
v) Cable attenuation : 0.3 dB/km
vi) Jumper cable loss : 2.5 dB
vii) Connector loss at each fiber joint : 1 dB

Assume two jumper cables and two cable joints. Compute the power margin of the link. Explain the significance of power budget and system margin. **(08 Marks)**

b. In a multimode link using LED as optical source, material dispersion related rise time degradation is 20 ns over the 5 km link. Receiver has 30 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, calculate link rise time. **(06 Marks)**

c. Explain with a neat diagram the functioning of radio-over-fiber links of a broadband wireless access network. **(06 Marks)**

7 a. Explain the operational principle and implementation of WDM with diagrams. **(07 Marks)**

b. Explain the functioning of optical isolator with sketches of components involved. **(06 Marks)**

c. Explain tunable light sources. **(07 Marks)**

8 a. Explain in detail the amplification mechanism with energy level diagram in an EDFA. **(08 Marks)**

b. Draw and explain the basic structure of an STS-N SONET and STM-N SDH frames. **(06 Marks)**

c. Explain the working of ultra-fast point-to-point transmission system using optical TDM operating at 160 Gb/s with a neat diagram. **(06 Marks)**

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