Kaferelsheikh University | **Faculty of Engineering**

Department of Electrical Engineering | **Year: 4th Electronics and Electrical Communications**

Subject: Optical Communication Systems | **Final Exam: 2 Pages**

Academic Number: ECE3010 | **Time allowed: 3 h**

Full Mark: 90 | **Date: 17/1/2019**

This exam measures the Intended Learning Outcomes (ILOs)

Field	National Academic Reference Standards (NARS)			
	Knowledge & Understanding	Intellectual Skills	Professional Skills	General Skills
academic standards that the course contribute in achieving it	a.18, a. 22, a.23, a. 26,	b.2, b.3, b.5	c.2, c.3, c.17, c.18	d.1, d.7

Answer the following questions:

[1] Question One: (15 Marks)

A- Draw the block diagram of the optical communication system and explain the operation of its blocks. (5 marks)

B- A photodiode has a quantum efficiency of 65% when photons of energy 1.5×10^{-19} J are incident upon it.

1. At what λ is the photodiode operating? (5 marks)
2. Calculate the incident optical power required to obtain a photocurrent of 2.5 μA when the photodiode is operating as described above. (5 marks)

[2] Question Two: (15 Marks)

A- What is meant by the link power budget for a digital optical communication system? Explain how this budget is performed and explain the factors that should be considered in this budget. (6 marks)

B- Does the dispersion mechanism in optical fibers affect the link power budget? Why? (4 marks)

C- Consider an optical link consists of a LED with output power of -10dB coupled into a fiber flylead. A silicon pin receiver with sensitivity of -42dB. Two connectors at the ends each has a loss of 2 dB. The fiber attenuation is α_f= 3dB/km. the system margin is 7 dB.

1. Draw the power loss model. (2 marks)
2. Find the length of the transmission path. (3 marks)

[3] Question Three: (20 Marks)

A- Draw the layout of the 2 x 2 silicon MZI multiplexer and explain its operation. (5 marks)

B- Assume that the input wavelengths of a 2 x 2 silicon MZI multiplexer are separated by 10GHz (ie. $\Delta\lambda = 0.08$ nm at $\lambda = 1550$nm). The effective refractive index $n_{eff} = 1.5$.

1. Calculate ΔL. (5 marks)
2. Design 4 x 4 silicon MZI multiplexer. (5 marks)
3. Draw the designed multiplexer stages. (5 marks)

[4] Question Four: (20 Marks)

A- Briefly describe the rise time budget for digital optical system performance analysis. (3 marks)

B- Find the rise time budget for a multimode link where (10 marks)

- The LED with its drive circuit has a rise time of 15 ns, and spectral width of 60 nm.
- The material dispersion related rise time degradation is about 21 ns over L=6km link.
- The receiver bandwidth is B_{rx}= 25MHz.
- The fiber has a bandwidth-distance product (B_0 = 400 MHz.km) and q=0.7.

For 20 Mb/s RZ data stream does the choice of the components is true?

C- Briefly explain the following points:

1. Automatic repeat request (ARQ) technique. (2 marks)
2. Reflection noise in optical system. (2 marks)
3. Speckle noise and how to eliminate. (3 marks)

[5] Question Five: (20 Marks)

A- Draw and explain the block diagram of wavelength division multiplexing (WDM) system. (5 marks)

B- Draw the 2 x 2 fused fiber optical coupler. Explain its fabrication process. Write down the general expressions for the coupled power P_2 and the throughout power P_1 in terms of the input power P_0. (5 marks)

C- Derive an expression for the scattering matrix of a 3 dB coupler with the aid of this matrix, Prove that the power is divided equally between the output ports in the 3 dB coupler. (5 marks)

D- Consider a 16 x 16 single mode coupler made from a cascade of 3dB fused-fiber 2x2 couplers. Where 95 percent of the power is passed through each element. Find;

1. The required number of 3 dB couplers. (without drawing) (2 marks)
2. Total loss (3 marks)

Best Wishes

Committee of Correctors and Testers

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