Kafrelsheikh University
Faculty of Engineering
Department of **Electrical Eng.**
Subject: Optical com. sys. , 4th year
Examiner: Dr. Bedir B. Yousif

Date: 11 /01 /2018
Time allowed: 3 Hours
Full mark: **90**
Final term Exam: Two pages
Academic Number: ECE 4121

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

Solve the following questions:-

Question One:- (30 mark)

1- An optical fiber has a core refractive index of 1.5. Two lengths of the fiber with smooth and perpendicular (to the core axes) end faces are butted together. Assuming the fiber axes are perfectly aligned, calculate the Fresnel reflection optical loss in decibels at the joint when there is a small air gap between the fiber end faces. (6 M)

2- State the main inherent connection problems when jointing fibers? (6 M)

3- A graded index fiber has a parabolic refractive index profile ($\alpha = 2$) and a core diameter of 50 μm. Estimate the insertion loss due to a 3 μm lateral misalignment at a fiber joint when there is index matching and assuming: (a) there is uniform illumination of all guided modes only; (b) there is uniform illumination of all guided and leaky modes. (6 M)

4- Two multimode step index fibers have numerical apertures of 0.2 and 0.4, respectively, and both have the same core refractive index of 1.48. Estimate the insertion loss at a joint in each fiber caused by a 5° angular misalignment of the fiber core axes. It may be assumed that the medium between the fibers is air. (6 M)

5- list the types of optical fiber couplers and its functions? (6 M)

Question Two:- (30 mark)

1- Explain the various loss parameters associated with four-port couplers? (6 M)

2- A four-port multimode fiber FBT coupler has 60 μW optical power launched into port 1. The measured output powers at ports 2, 3 and 4 are 0.004, 26.0 and 27.5 μW respectively. Determine the excess loss, the insertion losses between the input and output ports, the crosstalk and the split ratio for the device. (6 M)

3- A 32 × 32 port multimode fiber transmissive star coupler has 1 mW of optical power launched into a single input port. The average measured optical power at each output port is 14 μW. Calculate the total loss incurred by the star coupler and the average insertion loss through the device. (6 M)

1- Discuss the three main types of noise due to spontaneous fluctuations in optical fiber communication systems ? (6 M)

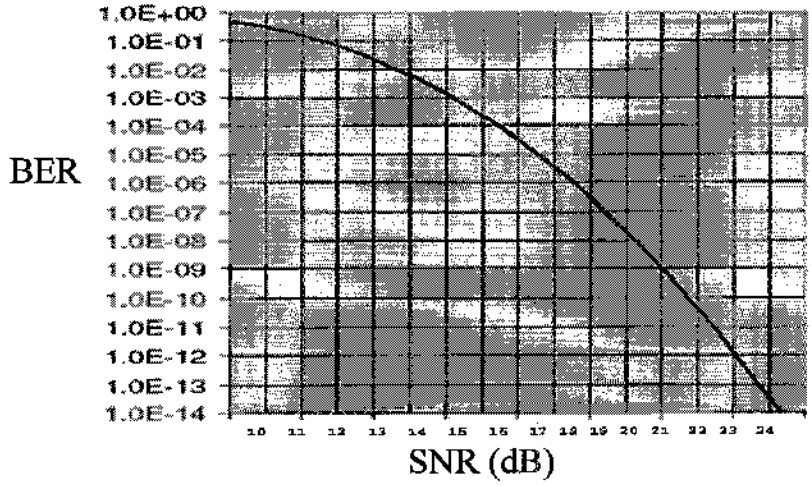
2- A digital optical fiber communication system operating at a wavelength of 1 μm requires a maximum bit-error-rate of 10^{-9}. Determine: (6 M)

(a) the theoretical quantum limit at the receiver in terms of the quantum efficiency of the detector and the energy of an incident photon;

(b) the minimum incident optical power required at the detector in order to achieve the above bit-error-rate when the system is employing ideal binary signaling at 10 Mbps, and assuming the detector is ideal.

Question Three:- (30 mark)

1- In a 1.55-μm long-haul fiber-optic system with the transmission distance 80 Km based on NRZ modulation code, and the system consists of 1- Optical fiber single mode cable with attenuation of 0.2 dBm/km, fiber spool = 10 km 2- Laser source with mean power = 5000 μW, at rise time 2 nS, and spectral width 2 nm. 3- Ge avalanche photodetector with minimum acceptable power -43 dBm, rise time 1 nS and responsivity of 5 A/W. 4- Two connectors pigtail of attenuation 1 dBm. Its required to give a complete performance analysis of system to satisfy a bit error rate of less than 10^{-9} and bit rate greater than 10 GHz. Hint use the following graph of bit error rate BER with SNR in your analysis. (15 M)



2. First, Calculate the PIN photodiode sensitivity if it has a quantum efficiency of 80% at operating Wavelength 1300 nm, signal to noise ratio 22 dB, and system bit rate 25 Gbps. Second, determine the type of optical fiber compatible with this detector when the transmission distance 15 Km. third, Find the actual power at receiver if the fiber spool 500 m with attenuation 0.2 dB/km, two connectors with 1dBm loss per connector, Average source output power is 7dBm. (15 M)

Best wishes of success

Dr. Bedir yousif