UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2012/2013

COURSE NAME	:	OPTICAL COMMUNICATION SYSTEM
COURSE CODE	:	BEP 4253 / BEX 43703
PROGRAMME	:	BEE
EXAMINATION DATE	:	JUNE 2013
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1 (a) Discuss the THREE (3) main reasons why optical fiber is a favored communication channel for long-haul communications as compared to copper channels.

(6 marks)

(b) Consider a piece of step-index optical fiber with a refractive index at the fiber core and cladding of 1.48 and 1.46, respectively.

(i) Calculate the refractive index change, Δ

(ii) What should be the maximum fiber core diameter if this fiber is designed to be single-mode for wavelength starting from 1100 nm? Assume $V \approx 2.405$.

(iii) Estimate the number of modes if the fiber is used for 850 nm laser.

(10 marks)

(c) Describe (with the aid of a simple ray diagram) how an optical signal propagates inside:

(i) the multimode step index fiber

(ii) the single-mode step index fiber

Discuss the advantages and disadvantages of these two types of fiber for the use as an optical channel.

(9 marks)

Q2 (a) Discuss in detail the reasons why a LED is not suitable for a broadband optical link.

(5 marks)

(b) Construct a typical graph of the output power vs current for a typical laser diode.

Then, show the output power spectrum of the laser diode when the laser diode is operating

(i) below the threshold current, and

(ii) after the threshold current

(8 marks)

(c) You have learned two splicing techniques, which are fusion splicing and mechanical splicing.

(i) Compare and discuss the splice loss between fusion splicing and mechanical splicing.

(ii) List the advantages and the disadvantages of these two types of splicing.

(iii) Discuss the possible application using this method in the optical field.

(12 marks)

Q3 (a) Define responsivity and quantum efficiency of a photodiode.

If a PIN photodiode has a quantum efficiency of 0.85 at 1550 nm, determine the responsivity.

(4 marks)

(b) For an analog receiver using p-i-n diode, discuss the effects of the following parameters on the signal-to-noise ratio (SNR) :

(i) modulation index,

(ii) received optical power, and

(iii) receiver bandwidth

(6 marks)

(c) Consider a 300 km telephone system, with splice every 10 km with loss of 0.1 dB. The cable has an attenuation of 0.025 dB/km at 1550 nm. It links two cities, Selangor to Batu Pahat, in a step index single mode fiber carrying a single wavelength at 2.5 Gbps. The links uses two optical amplifiers placed 100 km apart with each having gain of 30 dB. Both switching offices and optical amplifiers are connected with 1 dB connector termination at each end. Assuming that the chromatic dispersion of the fiber is specified at 3 ps/nmkm at 1550 nm. Both transmitter and receiver have similar rise time of 100 ps and the PIN photodetector sensitivity is at 40 dBm.

(i) Estimate the system power margin if coupled 0 dBm light source.

(ii) Estimate the system rise time budget in considering Fabri Perot laser with line width of 1 nm and Distributed Feedback laser of 0.1 nm.

(15 marks)

Q4 (a) Discuss the pros and cons of using optical amplifier compared to optical – electronic – optical (O/E/O) regenerator for long haul transmission.

(5 marks)

(b) Compare and discuss the THREE (3) major digital modulation schemes for optical communication, which are on-off keying (OOK), phase shift keying (PSK), and quadrature amplitude modulation (QAM), in terms of their way of operation, constellation diagram, channel capacity, advantages and disadvantages.

(15 marks)

(c) An optical system having a SNR = 10.8 dB for a thermal-limited constant power. The bandwidth of the system is 10 MHz. The detected signal

(c) An optical system having a SNR = 10.8 dB for a thermal-limited constant power. The bandwidth of the system is 10 MHz. The detected signal power at the receiver is 2×10^{-12} W and the thermal-noise power is 1.66×10^{-13} W at 300 K. Suppose that the photodetector is followed by an amplifier with a power gain of 10 dB and a noise temperature 454 K. Deduce the noise figure of the amplifier in dB.

(5 marks)

Q5 (a) Suggest THREE (3) methods to increase the transmission bit rate of a single mode silica optical fiber link.

(6 marks)

(b) The following parameters are established for a long haul single mode optical system operating at a wavelength of 1.3 μm.

Mean power launched from the laser transmitter	-3 dBm
Cable fiber loss	0.4 dB/km
Splice loss	0.1 dB/km
Connector losses at the transmitter and receiver	1 dB each
Mean power required at the APD receiver:	
When operating at 35 Mbit/s (BER 10^{-9})	-55 dBm
When operating at 44 Mbit/s (BER 10^{-9})	-44 dBm
Required safety margin	7 dB

Estimate

(i) The maximum possible link without repeaters when operating at 35 Mbit/s. It may be assumed that there is no-dispersion-equalization penalty at this rate.

(ii) The maximum possible link without repeaters when operating at 44 Mbit/s and assuming no-dispersion-equalization penalty.

dB. It may be assumed for the purposes of this estimate that the reduced link length has the 1.5 dB penalty.

(9 marks)

(c) 60-Mbps free space optic (FSO) is proposed to be used for internet connection between University of Excellence Malaysia main campus and its residential college. The line of sight (LOS) of the system is 1.5 km. In between the university and the college, there are some factories, houses, and big trees.

(i) Is this the best system that should be applied? Support your answer with some reasons. If the answer is negative, include problem statements and suggestions of improvement.

(ii) If the FSO is going to be replaced by an optical cable, predict the benefits and issues. Then, give your recommendations.

(10 marks)

- END OF QUESTION -