International Islamic University Chittagong (IIUC)

Department of Electronic and Telecommunication Engineering

Final Exam

Program: B.Sc (Engg.)
Course Code: ETE–4823/4843
Total Marks: 50

Semester: Spring2022
Course Title: Optical Fiber Communications
Time: 2.5Hours

(i) Answer all the questions. The figures in the right-hand margin indicate full marks.
(ii) Course Outcomes (COs) and Bloom's Levels are mentioned in additional Columns.

Course Outcomes (COs) of the Questions	
CLO1	Understand basics of optical communication systems.
CLO2	The practical techniques involved in real world optical fiber communication systems.

Bloom's Levels of the Questions						
Letter Symbols	R	U	Ap	An	E	C
Meaning	Remember	Understand	Apply	Analyze	Evaluate	Create

Part A

1.(a)	Explain the following noises due to spontaneous fluctuations in optical receivers: giving any relevant mathematical formulas. i) Thermal Noise ii) Quantum Noise iii) Dark Current noise	5	U	CLO1
1.(b)	An analog optical fiber system operating at a wavelength of 1550 nm has a post-detection bandwidth of 5 MHz. Assuming an ideal detector and considering only quantum noise on the signal, calculate the incident optical power necessary to achieve an SNR of 30 dB at the receiver. Justify your answer briefly	5	E	CLO2
2.(a)	Draw and explain the coherent detection receiver model for Amplitude Shift Keying (ASK) giving any relevant mathematical formulas.	5	An	CLO1
2.(b)	Point out the applications for the following amplifier configurations in optical fiber communications systems. i) In-line amplifier ii) Pre amplifier iii) Booster Amplifier	5	An	CLO1
	OR			
2.(a)	Explain the following terms and motive your answer briefly a) Erbium Doped Fiber Amplifier (EDFA) b) Amplified Spontaneous Emission (ASE) noise.	5	U	CLO1+ CLO2
2.(b)	Draw an Avalanche photodiode showing electric field region and explain why we have a high electric field gain region in APD.	5	E	CLO2

PART B

3.(a)	Explain, with the aid of a suitable block diagram, the generalized coherent optical fiber system. Motive your answer briefly.	5	U	CLO1
3.(b)	Calculate and justify the number of received photons per bit in order to maintain a BER of 10−9 for: (a) ASK heterodyne synchronous detection; (b) PSK homodyne detection. An ideal binary receiver may be assumed in all cases. Motive your answer briefly	5	E	CLO2

4.(a) Explain the link power Budge and Rise-Time Budget analysis for the total fiber communication system. An optical fiber system is to be designed to operate a 50 km length without repeaters. The rise time of the chosen components are
Source (LED) = 12 ns,
Fiber cable= 10ns/km.
intramodal= 0.5ns/km
and detector (PIN) = 13ns.
Determine and estimate the maximum bit rate using NRZ and RZ modulation format respectively. 7 U An CLO1+ CLO2

4.(b) An optical fiber link consists of multimode step index fiber which has a numerical aperture of 0.7 and a core refractive index of 3. The Rayleigh scattering coefficient for the fiber is $0.7km^{-1}$. When light pulses of 90 ns duration are launched into the fiber, Produce the ratio in decibels of backscattered optical power to the forward optical power at the fiber input. The velocity of light in a vacuum is $2.998x10^{8}\ ms^{-1}$. 3 C CLO2

5.(a) The following parameters are established for a long haul single mode optical fiber system operating at a wavelength of 1550nm. 7 E CLO2

Mean power launched from the laser transmitter	-3dBm
Cable fiber loss	0.2dB/km
Splice loss	0.01dB/km
connector losses at the transmitter and receiver	0.5dB each

Mean power required at the APD receiver:

When operating at 35Mbit/s(BER 10^{-9})	-55dBm
When operating at 400 Mbit/s(BER 10^{-9})	-44dBm
Required safety margin	3dB

Estimate and justify:

i) The maximum possible link length without repeaters when operating at 50Mbit/s (BER 10^{-9}). It may be assumed that there is no dispersion equalization penalty at this bit rate.

ii) The maximum possible link length without repeaters when operating at 1000 Mbit/s(BER 10^{-9})and assuming no dispersion equalization penalty.

iii) The reduction in the maximum possible link length without repeaters of (b) when there is a dispersion –equalization penalty of 1.0dB. it may be assumed for the purposes of this estimate that the reduced link length has the 0.5dB penalty.

5.(b) An optical power meter records optical signal power in either dBm or dBμ.Convert the optical signal powers of 7mW and 35 μ W to dBm. Justify your answer briefly. 3 An CLO2

OR

5.(a) Describe the Optical Time Domain Reflectometry (OTDR) Principle and illustrate a possible backscatter plot from a fiber under test. 5 U/E CLO1 &2

5.(b) Explain the main features of an optical long-haul network employing a wavelength division multiplexed transmission system. Differentiate between CWDM and DWDM techniques for optical transmission system. 5 U CLO1