International Islamic University Chittagong

Department of Electronic and Telecommunications Engineering

B. Sc. in ETE Semester Final Examination, Autumn-2022

Course Code: ETE-4823/4843, Course Title: Optical Fiber Communication

Time: 2:30 Hour Full Marks: 50

(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.	Explain the following nonlinear optical phenomena that occur during the transmission of the signal along the optical fiber, including any applicable mathematical calculations. i) Self-Phase modulation (SPM) ii) Four wave mixing (FWM) iii) Cross Phase modulation (XPM)	10	U	CLO1
2.(a)	Explain the core and surface interaction types of optical fiber couplers.	3	U	CLO1
(b)	Explain what is meant by the fusion splicing of optical fibers.	3	U	CLO1
(c)	A four port multimode fiber FBT coupler has 60μW 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 cross talk and the split ratio for the device	4	An	CLO2
	OR			
2.(a)	Briefly discuss the possible sources of noise in optical fiber receivers. Describe in detail what is meant by quantum noise. Consider this phenomenon with regard to: (a) digital signaling, (b) analog transmission, giving any relevant mathematical formulas	4	U	CLO1

2.(b)	A digital optical fiber communication system operating at a wavelength of 1550nmrequires a maximum bit error rate of 10^{-9}. Develop: 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 10Mbits/s and assuming the detector is ideal . Justify your answer briefly	6	C	CLO2
	PART B			
3.(a)	Provide an explanation for each of the following terms pertaining to the optical amplifier used in optical fiber communication and provide a concise justification for your answer. a) Amplified Spontaneous Emission (ASE) noise. b) Noise Figure(NF) c) Gain Flatness	6	E	CO1, CO2
3.(b)	Differentiate between Erbium Doped Fiber Amplifier (EDFA) and Raman amplifier. Which amplifier is better for long haul optical fiber communications? Justify your recommendations in this regard.	4	E	CO1, CO2
4.(a)	Discuss, with the aid of a suitable block diagram, a coherent optical fiber communication system. Comment on the differing system requirements to facilitate heterodyne detection in comparison with homodyne detection.	4	An	CLO1, CO2
4.(b)	Develop the absolute maximum repeater spacing that could be provided to maintain a BER of 10^{-9} within a coherent optical fiber system operating at a wavelength of 1550nm when the fiber and splice/connectors losses average out at 0.2dB/km, the optical power launched into the fiber link is 10dBm and the transmission rates are 50 Mbit/s and 10Gbit/s. For both bit rates consider the following ideal receiver types: i) ASK heterodyne synchronous detection ii) PSK homodyne detection.	6	C	CLO2
5.(a)	Describe the Optical Time Domain Reflectometry (OTDR) Principle and illustrate a possible backscatter plot from a fiber under test.	5	E	CLO1
5(b)	Derive an expression for total system rise time budget in terms of transmitter and receiver rise times for an optical communications system.	5	An	CLO1

	OR			
5.(a)	Differentiate between CWDM and DWDM multiplexing techniques for a long haul optical transmission system. Motive your answer briefly.	4	An	CLO1
5.(b)	A transmitter has an output power of 0.1 mW. It is used with a fiber having NA= 0.25, attenuation of 6 dB/km and length 0.5 km. The link contains two connectors of 2 dB average loss. The receiver has a minimum acceptable power (sensitivity) of – 35 dBm. The designer has allowed a 4 dB margin. develop the link power budget. Justify your answer briefly	4	C	CLO2
5.(c)	An optical power meter records optical signal power in either dBm or dB μ. i) Convert the optical signal powers of 15mW and 35 μ W to dBm ii) Convert optical signal powers of 0.6 mW and 60nW to dB μ Justify your answer briefly.	2	An	CLO1