GURU NANAK INSTITUTE OF TECHNOLOGY
An Autonomous Institute under MAKAUT
2022-2023
PHOTONICS AND OPTICAL COMMUNICATION
MCE104B

TIME ALLOTTED: 3 HOURS **FULL MARKS: 70**

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable

GROUP – A
(Multiple Choice Type Questions)

Answer any ***ten*** from the following, choosing the correct alternative of each question: **10×1=10**

		Marks	CO No
1.(i)	In the structure of fiber optic cable, the refractive index of core is always _____the refractive index of cladding. a) Less than b) Equal to c) Greater than d) None of the above	1	CO5
(ii)	In optical communication _____ acts as a transmission medium a) a)Coaxial cable b) Waveguide c) Optical fiber cable d) None of the above	1	CO4
(iii)	Which process gives the laser its special properties as an optical source? a) Dispersion b) Stimulated absorption c) Spontaneous emission d) Stimulated emission	1	CO3
(iv)	A device which converts electrical energy in the form of a current into optical energy is called as a) Optical source b) Optical coupler c) Optical isolator d) Circulator	1	CO1
(v)	How many propagation modes are present in single mode fibers? a) One b) Two c) Three d) Five	1	CO2

(vi)	The fraction of incident photons generated by photodiode of electrons generated collected at detector is known as a) Quantum efficiency b) Absorption coefficient c) Responsivity d) Anger recombination	1	CO3
(vii)	The light output from an LED is coupled into a step index fiber with a numerical aperture of 0.2, the coupling efficienct into the fiber will be a) 0.33 b) 1.48 c) 0.04 d) 0.9	1	CO4
(viii)	In the structure of a fiber, which component provides additional strength and prevents the fiber from any damage? a) Core b) Cladding c) Buffer Coating d) None of the above	1	CO3
(ix)	In the structure of fiber, the light is guided through the core due to total internal _____ a) reflection b) refraction c) diffraction d) dispersion	1	CO5
(x)	Optical fiber-couplers are also called as a) Isolators b) Circulators c) Directional couplers d) Attenuators	1	CO3
(xi)	Which splicing technique involves the alignment and locking of broken fiber edges by means of positioning devices & optical cement? a) Fusion b) Mechanical c) Both a and b d) None of the above	1	CO5
(xii)	Which type of fiber-optic coupler causes the distribution of an optical power from more than two input ports among the several output ports? a) Star Coupler b) Tree Coupler c) X Coupler d) All of the above	1	CO1

GROUP – B
(Short Answer Type Questions)
(Answer any *three* of the following) **3 x 5 = 15**

		Marks	CO No
2.	a) Describe basic block diagram of Optical Fiber communication. For b) n1 = 1.55 and n2 = 1.52. calculate the critical angle and numerical aperture	5	CO1
3.	What is spontaneous and Stimulated emission? Explain the process of population inversion with suitable energy level diagram of Laser.	5	CO1
4.	A silica optical fiber with a core diameter large enough to be considered by ray theory analysis has a core refractive index of 1.50 and a cladding refractive index of 1.47. Determine: (a) the critical angle of core-cladding interface (b) the NA for the fiber (c) the acceptance angle in air for the fiber.	5	CO1
5.	What is Optocoupler? Describe the different types of it with proper explanation.	5	CO3

GROUP – C
(Long Answer Type Questions)
(Answer any *three* of the following) **3 x 15 = 45**

		Marks	CO No
6. a)	Define Acceptance angle and Numerical aperture of an optical fiber with proper diagram. Deduce an expression for NA of a fiber with the help of a neat figure showing all the details.	5	CO5
b)	Explain 'Ray theory transmission' of optical fiber.	6	CO3
c)	The radiative and non-radiative recombination lifetimes of the minority carriers in the active region of an LED are 60 ns and 100 ns respectively. Determine the total carrier recombination lifetime and the power internally generated within the device when the peak emission wavelength is 0.87μm at a drive current of 40mA.	4	CO5
7. a)	Differentiate between connection-oriented and connection-less optical networks.	5	CO4
b)	Explain synchronous transmission mode and discuss its hierarchical features in relation to SONET and SDH optical networks.	7	CO4
c)	Describe the working principle of Fusion Splicer.	3	CO5
8. a)	Briefly describe the principle of operation of Optical Detection.	4	CO2
b)	Discuss the principle of operation of PIN photodiode.	4	CO2
c)	A four-port multimode fiber 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 27.5μW respectively. Determine the excess loss, the insertion losses between the input and output ports, the crosstalk and the split ratio for the device.	4	CO4
d)	Describe with the aid of suitable diagram the mechanism giving the emission of light from an LED.	3	CO2
9. a)	Describe the working principles of Avalanche Photo Diode (APD).	5	CO2
b)	Explain all aspects of link power budget.	3	CO4
c)	A D-IM analog optical fiber link of length 2 km employs an LED which launches mean optical power of -10dBm into a multimode optical fiber. The fiber cable exhibits a loss of3.5 dB/km with splice losses calculated at 0.7dB/km. In addition there is a connector loss at the receiver of 1.6 dB. The	4	CO4

p-i-n photodiode receiver has a sensitivity of -25 dBm for an SNR($\frac{i_{sig}^2}{i_N^2}$) of 50 dB and with a modulation index of 0.5.It is estimated that a safety margin of 4 dB is required. Assuming there is no dispersion –equalization penalty:

i) Perform an optical power budget for the system operating under the above conditions and ascertain its viability.

ii) Estimate any possible increase in link length which may be achieved using an injection laser source which launches mean optical power of 0 dBm into the fiber cable. In this case the safety margin must be increased to 7 dB.

d)	Estimate the maximum core diameter for an optical fiber with the relative refractive index difference of 1.5% and core refractive index of 1.48 in order to have single mode of operation. The fiber is operating in the wavelength of 0.85μm	3	CO5

10.	Write a short note on (any three)	3x5=15	
a)	WDM	5	CO1
b)	OCDM	5	CO3
c)	SONET	5	CO4
d)	Dispersion	5	CO4
e)	Skew Rays	5	CO5