30. a.i. An InGaAs pin photodiode has the following parameters at a wavelength of 1300 nm. $I_D = 4nA$, $\eta = 0.90$, $R_L = 1000\Omega$, and the surface leakage current is negligible. The incident optical power is $300nW$ $(-35\ dBm)$ and the receiver bandwidth is 20 MHz. Find the various noise terms of the receiver. Also, find the signal to noise ratio (SNR) value in dB. | 9 | 4 | 3 | 4

ii. Compare PIN and APD. | 3 | 3 | 3 | 2

(OR)

b. Draw the functional block diagram of optical receiver module and explain the operation of each block. | 12 | 3 | 3 | 2

31. a. Explain the concept of Raman-Nath and Bragg type acousto optic modulator with a neat diagram. | 12 | 3 | 4 | 3

(OR)

b. Describe about the Mach-Zehnder interferometer with input and output 3dB couplers and arrive at the expression for half wave voltage. | 12 | 4 | 4 | 2

32. a. Consider the design of a typical digital fiber-optic link which has to transmit at a data rate of $20Mbits/s$ with a BER of 10^{-9} using the NRZ code. The transmitter uses a GaAlAs LED emitting at 850 nm, which can couple on an average 100 mN $(-10dBm)$ of optical power into a fiber of core size 50 μm. The fiber cable consists of a graded-index fiber with the manufacturer's specifications as follows: $\alpha_f = 2.5dB/km$, $(\Delta T)_{mat}$ =3 ns/km, $(\Delta T)_{modal} = 1ns/km$. A silicon p-i-n photodiode has been chosen, for detecting 850 nm optical signals, for the front end of the receiver. The detector has a sensitivity of –42 dBm, in order to give the desired BER. The source along with its drive circuit has a rise time of 12 ns and the receiver has a receiver has a rise time of 11ns. The cable requires splicing every 1 km, with a loss of 0.5 dB/splice. Two connectors, one at the transmitter end and the other at the receiver end, are also required. The loss at each connector is 1 dB. It is predicted that a safety margin of 6 dB will be required. Estimate the maximum possible link length without repeaters and the total rise time of the system for assessing the feasibility of the desired system. | 12 | 4 | 5 | 2

(OR)

b. Write short notes on

(i) Optical isolator | 6 | 3 | 5 | 3

(ii) Optical MEMs switches | 6 | 3 | 5 | 3

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Reg. No. | | | | | | | | | | | | | | |

B.Tech. DEGREE EXAMINATION, NOVEMBER 2023

Seventh Semester

18ECE226T – OPTICAL COMPONENTS, SYSTEMS AND NETWORKS

(For the candidates admitted from the academic year 2018-2019 to 2019-2020)

Note:

(i) **Part - A** should be answered in OMR sheet within first 40 minutes and OMR sheet should be handed over to hall invigilator at the end of 40th minute.

(ii) **Part - B** and **Part - C** should be answered in answer booklet.

Time: 3 Hours | Max. Marks: 100

PART – A (20 × 1 = 20 Marks) | Marks | BL | CO | PO

Answer **ALL** Questions

1. A light ray is incident from medium-1 to medium-2. If the refractive indices of medium-1 and medium -2 are 1.5 and 1.36 respectively. Then determine the angle of refraction for an angle of incidence of 30°. | 1 | 3 | 1 | 2

(A) 40.5° (B) 38.68°

(C) 33.46° (D) 42.58°

2. When three wave components co-propagate at angular frequency w_1, w_2, w_3 then a new wave is generated at frequency w_4, which is given by _____ | 1 | 2 | 1 | 1

(A) $w_4 = w_1 - w_2 - w_3$ (B) $w_4 = w_1 + w_2 + w_3$

(C) $w_4 = w_1 + w_2 - w_3$ (D) $w_4 = w_1 - w_2 + w_3$

3. In fusion splicing, the splice losses typically are in the range of | 1 | 1 | 1 | 1

(A) 0.05-0.10 dB (B) 0.1-0.2 dB

(C) 0.07-0.2 dB (D) 0.2-0.5 dB

4. What is the numerical aperture of an optical fiber having a core refractive index of 1.6 and cladding refractive index of 1.50? | 1 | 2 | 1 | 2

(A) 0.557 (B) 0.432

(C) 0.321 (D) 0.382

5. Calculate the external quantum efficiency of LED having the refractive index of 3.5 | 1 | 1 | 2 | 2

(A) 2.41 % (B) 1.41%

(C) 3.41 % (D) 4.41%

6. Name the circuit which is to provide electrical power to the optical source and to modulate the light output | 1 | 1 | 2 | 1

(A) Mixing circuitry (B) Driving circuitry

(C) Demodulating circuitry (D) Local oscillator circuitry

7. Light from a source is said to be monochromatic, if it has _____spectral width and _____wavelengths. | 1 | 1 | 2 | 1

(A) Wider, fewer (B) Narrow, fewer

(C) Wider, more (D) Narrow, more

8. An injection laser has active cavity losses of $30cm^{-1}$ and the reflectivity of each laser facet is 40%. Determine the laser gain coefficient for the cavity it has a length of 400 μm. | 1 | 3 | 2 | 2

(A) $46.03cm^{-1}$ (B) $51.36cm^{-1}$

(C) $52.9cm^{-1}$ (D) $49.07cm^{-1}$

9.	In a 100 ns pulse, 6×10^6 photons at a wavelength of 1310 nm fall on an INGAAs photodetector. On an average 5.4×10^6 electron-hole pairs are generates then the quantum efficiency is (A) 90% (B) 85% (C) 60% (D) 45%	1	2	3	2
10.	To achieve 0.001 nm wavelength accuracy spectrum analyzers use _____ (A) Diffraction grating (B) Michelson interferometer (C) Fabry perot interferometer (D) Glass prism	1	1	3	1
11.	The average number of electron-hole pairs created by a carrier per unit distance travelled is called the _____ (A) Quantum rate (B) Impact rate (C) Ionization rate (D) Bit rate	1	1	3	2
12.	Name the circuit which is used to provide electrical power to the optical source and to modulate the light output (A) Mixing circuitry (B) Driving circuitry (C) Demodulating circuitry (D) Local oscillator circuitry	1	1	3	1
13.	In a longitudinal electro optic modulator, half wave voltage is that voltage which introduces the following phase shift between two polarization components (A) $\pi/4$ (B) $\pi/2$ (C) π (D) 2π	1	1	4	3
14.	In slab waveguide, the top most layer is often air and consequently has a refractive index _____ (A) Much lower that guide layer or substrate (B) Much higher than guide layer or substrate (C) Sum of guide layer and substrate (D) Difference of guide layer and substrate	1	1	4	3
15.	Losses in integrated optics waveguide are usually much _____that in optical fibers, being of the order of _____dB/mm. (A) Higher, 0.1 (B) Lower, 0.1 (C) Higher, 0.01 (D) Lower, 0.01	1	1	4	3
16.	The kerr electro optic coefficients are (A) Linear (B) Quadratic (C) Cubic (D) Biquadratic	1	1	4	1
17.	Total optical loss (P_T) is given by _____ P_S – source power P_R – receiver power (A) $P_T = P_S - P_R$ (B) $P_T = P_R - P_S$ (C) $P_T = P_R - P_S + 1$ (D) $P_T = P_S - P_S - 1$	1	1	5	3
18.	The methods for transmitting microwave analog signals over an optical fiber link have become known as _____techniques. (A) RF-over-Fiber (B) AF-over-Fiber (C) Analog modulation (D) Digital modulation	1	1	5	2

19.	A device which is made of isolator and follows a closed loop path is called as a _____ (A) Circulator (B) Gyrator (C) Attenuator (D) Connector	1	1	5	3
20.	_____couplers divide the power equally (A) 3 dB (B) 6 dB (C) 8 dB (D) 12 dB	1	1	5	3

PART – B (5 × 4 = 20 Marks)

Answer **ANY FIVE** Questions

		Marks	BL	CO	PO
21.	Compare the types of fiber in terms of structure, RI profile, ray propagation and pulse broadening. Justify the importance of SM fiber in long haul high data rate communication.	4	3	1	1
22.	What are the limitations of dispersion? Explain how the choice of light source plays a role in material dispersion.	4	2	1	1
23.	Explain the principle of photoluminescence and its application as a display device.	4	2	2	2
24.	Sketch and explain the operation on the modulation circuit in an optical transmitter module.	4	2	3	2
25.	Photodiodes are reverse biased state the reasons to substantiate the same.	4	3	3	2
26.	With the single arm MZI explain the modulation characteristics of it as interferometric modulator.	4	3	4	3
27.	What is the need for multiplexing? Sketch the different multiplexing techniques for increasing the transmission capacity of an optical fiber.	4	2	5	3

PART – C (5 × 12 = 60 Marks)

Answer **ALL** Questions

		Marks	BL	CO	PO
28. a.	From the wave equations of the step-index fibers arrive at the boundary conditions for bounded modes.	12	4	1	4
	(OR)				
b.	What are the limitations of dispersion? Discuss on inter and intramodal dispersion with appropriate expressions.	12	2	1	1
29. a.	Define internal and external quantum efficiency of an LED. Show that the optical power emitted from the LED is $P = \frac{P_{\text{int}}}{n(n+1)^2}$ where P_{int} is the internally generates optical power, 'n' is the refractive index of LED materials.	12	4	2	2
	(OR)				
b.	List the various transition process of Erbium doped fiber amplifier (EDFA) with neat energy diagram and explain the amplification mechanism.	12	3	2	2