

Test: CLAT- 3

Date: 21-6-2022

Course Code & Title: 18ECE322T – OPTOELECTRONICS

Duration: 08:00 – 09:40 PM

 Year & Sem: II / 4th Sem

Max. Marks: 50

Course Articulation Matrix with PI:

18ECE322T: Optoelectronics		Program Outcomes (POs)																								PSO			
COs	Course Outcomes	BL	1	PI	2	PI	3	PI	4	PI	5	PI	6	PI	7	PI	8	PI	9	PI	10	PI	11	PI	12	PI	1	2	3
CO-1:	Define the basic concepts of optics and semiconductor optics.	1	3	1.4.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
CO-2:	Demonstrate the working principle of various photonic sources and display devices.	3	3	1.2.1	3	2.1.2	-	-	2	4.1.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-3:	Analyze the principle and operation of various detectors and noise associated with it.	4	-	-	3	2.1.3	2	3.1.1	3	4.1.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-4:	Interpret the various optoelectronic modulators, switches, and interconnects.	3	3	1.3.1	2	2.2.1	3	3.2.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-5:	Apply the concepts of integrated optoelectronic components and its application in various fields.	3	3	1.4.1	-	-	3	3.2.2	3	4.2.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3

Part – A

(10 x 1 = 10 Marks)

Instructions: Answer ALL the Questions

Q. No	Question	Marks	BL	CO	PO	PI
1	(B) Pockels effect	1	1	4	1	1.3.1
2	(C) Modulating the diffraction angle	1	2	4	1	1.3.1
3	(B) 330nm	1	2	4	1	1.3.1
4	(D) 3dB coupler	1	1	4	3	3.2.1
5	(A) Lack of compactness and parasitic effects from leads and connectors	1	2	4	1	1.3.1
6	(D) Higher than	1	1	5	1	1.3.1
7	(A) Phased-array antennas	1	2	5	1	1.3.1
8	(B). High power laser	1	1	5	3	3.2.1
9	(C). OEIC Velocimeter	1	2	5	3	3.2.1
10	(D) LiNbO3	1	1	5	3	3.2.1

Part – B

(4 x 10 = 40 Marks)

SECTION B1

Instructions: Answer ANY 2 Questions

11	<p>Photoelastic Effect</p> <p>Change in Refractive index $\Delta\left(\frac{1}{n^2}\right) = p_{ij} S_j$ Photoelastic coefficient</p> <p>The strain changes the density of the crystal and through the Poisson effect, the electron orbitals, which lead to a change in the refractive index.</p> <p>Acoustic wavelength λ_a $\lambda_a \ll \Lambda^2/\lambda$ $\lambda_a \gg \Lambda^2/\lambda$</p> <p>Wavelength of light $\Lambda = v_a/f$ $\Lambda = v_a/f$</p> <p>Acoustic frequency f f</p> <p>RAMAN BRAGG</p> <p>Bragg Regime</p> <p>Acoustic wave, Incident light, 1st order diffracted beam, Through beam</p> <p>Consider two coherent optical waves a and b being reflected from two adjacent acoustic wave fronts to become a_1 and b_1. These reflected waves can only interfere the diffracted beam if they are in phase. The angle θ is designated Bragg angle, this is a few degrees.</p>	5	4	4	1	1.3.1
		5	3	4	1	1.3.1

12	<p>LiNbO₃ based Mach-Zehnder type single mode waveguide modulator (3M) Explanation on constructive and destructive interference concept (2M)</p>	5	3	4	3	3.2.1
	<p>Faraday Effect (Rotation)</p> <p>The sense of rotation of the optical field E depends only on the direction of the magnetic field for a given medium (given Verdet constant). If light is reflected back into the Faraday medium, the field rotates a further θ in the same sense to come out as E' with a 2θ rotation with respect to E.(3M)</p> <p>calculate the Faraday rotation angle for a 3 cm cavity operated at 0.9T when exposed to 630 nm Laser source. Given verdet constant 60 rad/T-m. Theta=VBL(1M) Ans: 1.62 rad or 92.81 Degree.....(1M)</p>	5	3	4	4	4.2.1
13	<p>T-coupler 3-dB coupler or (a) T-coupler (b) 3-dB coupler (2M)</p> <p>• Key specifications of optical couplers</p> $\text{Insertion Loss(dB)} = 10 \log \frac{P_{in}(\text{mW})}{P_{out}(\text{mW})}$ $\text{Excess Loss(dB)} = 10 \log \frac{P_{port1}(\text{mW})}{P_{port2}(\text{mW}) + P_{port3}(\text{mW})}$ <p>(3M)</p>	5	3	4	3	3.2.1
	<p>Figure 20.3-4 (a) An optical switch as a 2×2 switch. (b) An interconnect with a phase modulator as a 2×2 switch. (c) An interconnect with a phase modulator as a 2×2 switch. (2M)</p> <p>Switch Characteristics A switch is characterized by the following parameters:</p> <ul style="list-style-type: none"> • Size (number of input and output lines) and direction(s), i.e., whether data can be transferred in one or two directions. • Switching time (time necessary for the switch to be reconfigured). • Propagation delay time (time taken by the signal to cross the switch). • Throughput (maximum data rate that can flow through the switch). • Switching energy (energy needed to activate and deactivate the switch). • Power dissipation (energy dissipated per second in the process of switching). • Insertion loss (drop in signal power introduced by the connection). • Crosstalk (undesired power leakage to other lines). • Blocking probability. Probability that a connection cannot be established because of a conflict with another connection. • Physical dimensions. This is important when large arrays of switches are built. (3M) 	5	3	4	1	1.2.1
<p align="center">SECTION B2 Instructions: Answer ANY 2 Questions</p>						
14	<p>Need for Integration</p> <ul style="list-style-type: none"> • Input – output isolation not provided in optics. • Difficult to focus multiple beams in a parallel system. • Hence, logical to couple electronic and photonic devices (Optoelectronic integration). • Electrical interconnect media adversely affected by <ul style="list-style-type: none"> • Increase in resistance • Reflections due to impedance mismatch at higher frequencies • Multilevel board technology fail to perform at GHz range (3M) <p>Hybrid Integration Monolithic Integration (2M)</p>	5	2	5	1	1.3.1
	<p>Two basic possibilities exist for making 3D structures: (3M)</p>	5	3	5	3	3.2.1

	<p>The field distribution of a symmetric waveguide in a dielectric slab</p>								
15	<p>Fig. 30.2 An integrated-optic Doppler velocimeter</p>	5	4	5	1	1.3.1			
	<p>Fig. 30.3 DBR laser structure in GaAs waveguide by direct measurement [2]</p>	5	4	5	1	1.3.1			
	<p>Fig. 30.4 Schematic diagram of a wavelength-multiplexed light source [3]</p>	5	4	5	1	1.3.1			
16	<p>Fig. 30.5 PIN-PD and J-FET circuit diagram</p>	5	4	5	3	3.2.1			
	<p>Fig. 30.6 PIN-PD and J-FET structure diagram</p>	5	4	5	3	3.2.1			
	<p>Fig. 30.7 PIN-PD and J-FET structure diagram</p>	5	4	5	3	3.2.1			