Marking Scheme

Total No. of Questions – [10] Total No. of Printed Pages: 4

G.R. No. U118-104CB(ESE)

DECEMBER 2018 / END-SEM

F. Y. B.TECH. ([illegible]/CB) (SEMESTER - I)

COURSE NAME: Engineering Physics (CB)

COURSE CODE: ES10184A-CB

(PATTERN 2018)

Time: [2 Hours] [Max. Marks: 50]

Instructions to candidates:

1) **Attempt Q.1, Q.2, Q.3, Q.4 ORQ.5, Q.6 OR Q.7,Q.8 OR Q.9 and Q.10**
2) **Figures to the right indicate full marks.**
3) **Use of scientific calculator is allowed.**
4) **Use suitable data where ever required.**

Q	Question	Marks	Marking Scheme	Cognitive	Difficulty	CO
Q1 (a)	With the help of a neat diagram, explain the working of anti-reflection coating (ARC) on the basis of interference from a thin film. Derive (a) the minimum thickness and (b) refractive index of the ARC for normal incidence of light.	[4]	Diagram - 1Mark Working – 1 Mark Derivation of t & μ for normal incidence - 1Mark each	U C	M	1
	OR					
Q1 (b)	Starting from the expression for resultant amplitude of a grating, obtain conditions for principal maxima and minima. If sodium light is used as a source, will the 5890Å and 5896Å lines, present in the source, be better resolved in 1st or 2nd order?	[4]	Expression for resultant amplitude - 1Mark Conditions for maxima & minima – 1 Mark each Answer to resolution – 1 Mark	U C A	M	1
Q2 (a)	Draw the energy level diagram for an unbiased p-n junction diode at equilibrium. Explain the formation of built in potential on the basis of charge re-distribution in both regions. Derive the expression for built in potential (V_{bi}) for a p-n junction diode.	[4]	Diagram – 1 Mark Explanation – 1 Mark Derivation of V_{bi} -2 Marks	U C	M	2
	OR					
Q2 (b)	Calculate the built in potential V_{bi} for a diode with a doping of 3.1 × 10^{14} /cm^3 on the n-side and 7.2 × 10^{16} /cm^3 on the p-side. The intrinsic charge carrier density at room temperature (T = 300K) for Silicon is 2.1 × 10^{10} /cm^3. Given, k = 1.38 × 10^{-23} J/K and e = 1.6 × 10^{-19} C.	[4]	$V_{bi} = 0.0258$ $ln\left(\frac{3.1 \times 10^{14} \times 7.2 \times 10^{16}}{2.1^{2} \times 10^{20}}\right)$ $V_{bi} = 0.0258$ $ln\left(\frac{22.32 \times 10^{30}}{2.1^{2} \times 10^{20}}\right)$ $=0.0258\, ln(\overset{5.06}{\cancel{10.63}} \times 10^{10})=$ $0.0258 \times 25.39= \cancel{0.66\, eV}$ 24.65 = 0.637 eV	A	M	2

Q3 (a)	What are direct and indirect band gap materials? Illustrate with the help of E-K diagram. Explain how recombinations are facilitated by iso-electronic trap levels	[6]	Explanation- 1Mark Diagram - 1Mark Illustrating using diagram – 1Mark Explanation of recombination – 1 Mark	U C	M	3
	OR					
Q3 (b)	With the help of a neatly labeled energy diagram and the physical picture of a photo diode, explain its action.	[6]	Energy level diagram - 1Mark Picture of diode – 1Mark Explanation of action – 2 Marks	U C	M	3
Q4 (a)	Writing down the expressions for rates of absorption, spontaneous and stimulated emissions, define Einstein coefficients. Hence obtain the condition for light amplification and explain the same.	[6]	Expressions & definition – 2 Marks in totality Condition for light amplification – 1 Mark Explanation – 1 Mark	U C	M	4
Q4 (b)	Explain how the property of unidirectionality is achieved for a laser using optical cavity.	[4]	Diagram of optical cavity – 1 Mark Explanation – 3 Marks	U C	L	
	OR					
Q5 (a)	With the help of a neatly labelled diagram, explain principle, construction and working of a single heterogeneous laser.	[6]	Diagram - 1Mark Principle - 1Mark Construction - 2Marks Working - 2Marks	U C	M	4
Q5 (b)	In the case of a He-Ne laser, the output beam spot diameters are 3 mm and 5 mm at distances of 1.5 m and 3.5 m respectively. Calculate the laser beam divergence.	[4]	$\theta \cong \frac{(d_2-d_1)/2}{L_2-L_1} = \frac{(5-3)/2\times10^{-3}}{3.5-1.5} =$ 0.5×10^{-3} radian = 0.029°	A	L	4
Q6 (a)	Obtain an expression for the acceptance angle for an optical fiber.	[6]	Derivation - 6Marks	U C	M	5
Q6 (b)	If the spectral width Δλ=340 Å at λ = 5500Å for a green LED and for the optical fibre, the material dispersion $\left(\lambda^2 \frac{d^2n_1}{d\lambda^2}\right) = 0.015$. Calculate the material pulse broadening (Δt_m) for an optical fibre of length $L = 5$ km. What is its value if a laser with the same wavelength but Δλ = 50 Å is used. Calculate B_{max} for both.	[4]	For the LED, $(\Delta t)_m = \frac{\Delta\lambda L}{\lambda c}\left\|\lambda^2 \frac{d^2n_1}{d\lambda^2}\right\|$ $= \frac{340Å \times 5 \times 10^3 m}{5500Å \times 3 \times \frac{10^8 m}{s}} \times 0.015$ $= 1.55 \times 10^{-8}\ seconds$ $B_{max} = \frac{0.2}{1.55 \times 10^{-8}} = 12.9 \times 10$ $i.e\ 12.9\ Mbps$ For the laser, $(\Delta t)_m = 0.23 \times 10^{-8}\ seconds$ $B_{max} = \frac{0.2}{0.23 \times 10^{-8}}$ $= 0.87 \times 10^8 \frac{bits}{s},\ i.e\ 0.87\ Gbp$	A	H	5
	OR					
Q7 (a)	Explain, in detail, the various causes for	[6]	Explanation of 3 causes – 2	U	M	5

	attenuation of a signal in fiber optic communication.		Marks each	C		
Q7 (b)	If the mean optical power launched into a 100 km long optical fibre is 570 μW and that at the output is 12 μW, then calculate the decibel attenuation and the loss parameter.	[4]	$10log_{10}\left(\frac{P_i}{P_o}\right) = 10log_{10}\left(\frac{570}{12}\right)$ $= 16.78\ dB$ $\alpha_{dB} = \frac{16.78}{\textcircled{8}} \sim 2.10\ dB/km$ 100 1.68 dB.	A	M	5
Q8 (a)	List the various types of noise associated with a resistor. Explain any two of them in detail.	[6]	Listing types of noise – 1 Mark Explanation – 2.5marks each	C	M	6
Q8 (b)	If the resistance of a Pt resistor with $R_0 = 100\Omega$ at 0°C, what is its resistance at 250°C and -250°C? Given A = 3.9083×10^{-3} /°C and B = -5.775×10^{-7} /°C.	[4]	$R_T = R_0(1 + AT + BT^2)$ (i) $R_{250} = 100(1 + 3.9083 \times 10^{-3} \times 250 - 5.775 \times 10^{-7} \times 250^2)$ $= 100(1 + 3.9083 \times 10^{-3} \times 250 - 3.6094 \times 10^{-3})$ $= 100(1 + 0.9771 - 3.9083 \times 10^{-3})$ $= 100(1.9771 - 3.9083 \times 10^{-3})$ $= 100(1.9732) = 197.32\ \Omega$ (ii) $R_{-250} = 100(1 - 3.9083 \times 10^{-3} \times 250 - 5.775 \times 10^{-7} \times (-250)^2)$ $=100(1 - 3.9083 \times 10^{-3} \times 250 - 3.6094 \times 10^{-3})$ $= 100(1 - 0.9771 - 3.9083 \times 10^{-3})$ $= 100(1 - 0.9810)$ $= 100(0.019) = 1.9\ \Omega$			
	OR					
Q9 (a)	Derive the expression of $\frac{\Delta C}{C}$ for a capacitance sensor for a change in the gap of a parallel plate capacitor. Give two examples of where it could be used.	[6]	Derivation – 4 Marks Examples – 1 Mark each	C	H	6
Q9 (b)	Give the principle of a Hall sensor and explain how it can be used in two applications.	[4]	Principle – 1 Mark Explanation of 2 examples – 1.5 marks each	U C	M	6
Q10 (a)	The Numerical Aperture (NA) of an optical f depends on (i)The refractive index of the cladding alone (ii) The refractive index of the core alone (iii) the refractive indices of the core and cladding	[1]	(iii)	U C A	M	5

	(iv) The refractive index of neither the core nor the cladding					
Q10(b)	When a pulse of light is launched into an opt fiber, as it travels ………… is observed. (i)the pulse becomes narrower and the height of pulse becomes larger (ii)the pulse broadens and the height of the pu remains constant (iii) the pulse broadens and the height of the pu becomes smaller (iv)the pulse width and height remain constant	[1]	(iii)	U C A	M	5
Q10(c)	For a single mode step index fiber, the interme dispersion is remedied by (i)By changing the refractive continuously from core to the cladding (ii) by reducing the radius of the core (iii) by having a step change in refractive index core and cladding (iv) by reducing length of the fiber	[1]	(ii)	U C A	M	5
Q10(d)	For a current of 2μA measured with electronics v a band width of 10kHz, shot noise will be ………..	[1]	$1.265 \times 10^{-4}\mu A$ (i)	A	L	6
Q10(e)	Johnson noise can be reduced by decreasing ………….of the measuring instrument. (i)Voltage (ii) Power (iii) Bandwidth (iv) Frequency	[1]	(iii)	U C	M	6
Q10(f)	If the separation between the plates of a capacita sensor is reduced to one fourth of its earlier value the capacitance ………..the previous value. (i)Double (ii) 4 times (iii) Half (iv) One fourth	[1]	(ii)	U C A	M	6