SIES (Affiliated to University of Mumbai)	***End Semester Examination (R-24) FH 2026 Answer Key with marking scheme***
Branch: IT/ IOT	**Course:** Applied Physics
Year/ Semester: FE/ II	**Course code:** FEC2021
Time: 03 hours	**Marks: 80**

Q1. $\beta = \frac{\lambda}{2\mu\theta}$. $\mu_{air} = 1$

(A) $\beta = \frac{3.2mm}{30} = \frac{3.2\times10^{-3}}{30} = 1.067\times10^{-4} m$ — 1

$\theta = \frac{\lambda}{2\beta} = \frac{5.89\times10^{-7} m}{2\times1.067\times10^{-4}} = 2.76\times10^{-3}$ radians — 2

$= 2.76\times10^{-3}\times\frac{180}{\pi}$ — 1

$= 0.158°$

Converts into minutes & Seconds

$\left.\begin{array}{l}\cdot\text{Degrees} = 0.158° \\ \text{Minutes} = 0.158\times60 = 9.48' \\ \text{Seconds} = 0.48\times60 = 29''\end{array}\right\}$ — 1

(B) Construction + diagram — 2

Working + Energy level diagram — 3

(C) 4 points — 4

Diagram of direct & indirect semiconductor — 1

(D) $\left.\begin{array}{l}\cdot\text{Derivation of schrodinger's eq}^n \\ i\hbar\frac{\partial\psi}{\partial t} = \frac{-\hbar^2}{2m}\frac{\partial^2\psi}{\partial x^2} + V\psi\end{array}\right\}$ — 5

(E) Optical sensor — 1

Diagram — 1

Construction — 1

Working — 2

(F) Concept of top-down approach — 2

Ball milling - diagram — 1

Explanation — 2

Q2 (A) Newton's rings diagram — (1)

Derivation } — (4)

$r_n = \sqrt{n\lambda R}$

Given $\lambda_1 = 5500 A^\circ$, $R = 90cm$

$\lambda_2 = 5000 A^\circ$

n^{th} dark ring of λ_1 coincides with $(n+3)^{th}$ of λ_2

$n\lambda_1 = (n+3)\lambda_2$ — (1)

$n(5500) = (n+3)(5000)$ — (1)

$n = 30$

$r_n = \sqrt{n\lambda R} = \sqrt{30 \times 5.5 \times 10^{-5} \times 90}$ — (2)

$= 0.385 cm$ — (1)

(B) Derivation of NA

Diagram } (5)

$NA = \sin\theta_a = \sqrt{n_1^2 - n_2^2}$

Given:- $n_1 = 1.49$

$n_2 = 1.44$

(Radius) $a = 90 \mu m = 90 \times 10^{-6} m$

$\lambda = 750 nm = 750 \times 10^{-9} m$

$\sin\theta_c = \frac{n_2}{n_1} \Rightarrow \theta_c = \sin^{-1}(0.9664) = 75.2^\circ$ — (2)

$NA = \sqrt{n_1^2 - n_2^2} = \sqrt{(1.49)^2 - (1.44)^2} = 0.383$ — (1)

$V = \frac{2\pi a}{\lambda} \times NA = \frac{2\pi \times 90 \times 10^{-6}}{750 \times 10^{-9}} \times 0.383$

$V = \cancel{2} 289$ } — (2)

(C) Statement of Hall effect — (2)

Diagram — (1)

Derivation of hall voltage — (3)

— " — hall coefficient — (2)

Physical significance — (2)

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Q2 (D) $E_n = \frac{n^2h^2}{8mL^2}$ Derivation — (5)

Given :- $L = 5.3 A^\circ = 5.3 \times 10^{-10} m$

Ground state energy: (n=1)

$$E_1 = \frac{n^2h^2}{8mL^2} = \frac{(6.626 \times 10^{-34})^2}{8(9.11 \times 10^{-31})(5.3 \times 10^{-10})^2} \quad — (2)$$

$$= 2.14 \times 10^{-19} J$$

In eV :- $E_1 = \frac{2.14 \times 10^{-19} J}{1.6 \times 10^{-19}} = 1.34 eV$ — (1)

First excited state energy

$(n=2)$ $E_2 = 4E_1$

$E_2 = 5.36 eV$ } — (2)

(E) Wave function & significance — (5)

Given:- $v = 900$ m/s

$\Delta v = 9 \times 10^{-3}$ m/s — (1)

$\Delta x \cdot \Delta p \geq \frac{h}{2\pi}$ — (1)

$\Delta x \cdot m\Delta v \geq \frac{h}{2\pi}$

$\Delta x = \frac{6.626 \times 10^{-34}}{2\pi \times 9.11 \times 10^{-31} \times 9 \times 10^{-3}}$ } (2)

$= 1.29 \times 10^{-2} m$ — (1)

(F) Principle — (1)

construction with diagram — (3)

~~for~~ working of AFM — (3)

Comparison — (3)

Q3 (A) Phase condition of antireflection coating
& Amplitude condition } — (5)

(B) Principle of laser — (2)
Comparision of spontaneous & stimulated emission — (3)

(C)

$\sigma = ne\mu$

$\frac{1}{\rho} = ne\mu$

$\mu = \frac{1}{ne\rho}$

Given :- $\rho = 1.72 \times 10^{-8}\, \Omega m$
$n = 10.41 \times 10^{28} /m^3$
q } — (2)

$= \frac{1}{(1.72 \times 10^{-8})(10.41 \times 10^{28})(1.6 \times 10^{-19})}$ } — (2)

$= \frac{1}{286.5}$

$\mu = 3.49 \times 10^{-3}\ m^2/V\text{-}s$ — (1)

(D) Debroglie hypothesis — (1)
Derivation for K.E — (2)
— " — PE — (2)

(E) Transducer — (1)
PT 100 construction — (2)
Working with diagram — (2)

(F) $t = 5.6\,mm = 5.6 \times 10^{-3}\, m$
$Y = 7.9 \times 10^{10}\ N/m^2$
$\rho = 2650\, kg/m^3$

$f = \frac{1}{2t}\sqrt{\frac{Y}{\rho}} = \frac{1}{2 \times 5.6 \times 10^{-3}}\sqrt{\frac{7.9 \times 10^{10}}{2650}}$

$f = 4.88 \times 10^{5}\ Hz$