SIES Graduate School of Technology (Autonomous) NAAC A+ (Affiliated to University of Mumbai)	***End Semester Examination (R-24) SH 2025***
Branch: EXTC/ECS/CE	Course: Applied Physics
Year/ Semester: 2025-26/ I	Course code:FEC1021
Time: 03 hours	Marks: 80

Q1 Attempt any four

A) Explanation of thin film - 2M
Derivation - 3M

B) Construction & reconstruction diagram - 2M
Explanation of Hologram - 3M

C) Given - $E_f - E = 0.012\ eV$

$K = 1.38 \times 10^{-23}\ J/K.$

$K = 8.625 \times 10^{-5}\ eV/K$

$T = 300K$

Formula -

$$f(E) = \frac{1}{1 + \exp\left(\frac{E - E_f}{KT}\right)}$$

To find : $1 - f(E) = ?$

Soln -

$$1 - f(E) = 1 - \frac{1}{1 + \exp\left(\frac{E - E_f}{KT}\right)} = 1 - \frac{1}{1 + \exp\left(\frac{0.012}{8.625 \times 10^{-5} \times 300}\right)}$$

$$= 1 - 0.614$$

$$\boxed{1 - f(E) = 0.386}$$

D) Given - $E = 1 KeV = 1 \times 10^{3} eV = 1.6 \times 10^{-19} J$

$\Delta x = 10 nm = 10 \times 10^{-9} m$

formula: $KE = \frac{1}{2} m v^2$

$E = \frac{p^2}{2m}$

$p^2 = 2mE$ } 1M

$p = \sqrt{2mE} = \sqrt{2 \times 9.1 \times 10^{-31} \times 10^{3} \times 1.6 \times 10^{-19}}$

$p = 1.706 \times 10^{-23}$ Kg m/sec - 1M

HUP, $\Delta x \cdot \Delta p \geq \hbar = \frac{h}{2\pi}$ - 1M

$\Delta p = \frac{h}{2\pi} \times \frac{1}{\Delta x}$

$\Delta p = \frac{6.63 \times 10^{-34}}{2\pi} \times \frac{1}{10 \times 10^{-9}}$

$\Delta p = 1.055 \times 10^{-26}$ Kgm/sec - 1M

$\% \Delta p = \frac{\Delta p}{p} \times 100 = \frac{1.055 \times 10^{-26}}{1.7062 \times 10^{-23}} \times 100$

$\therefore \Delta p = 6.18 \times 10^{-4} \%$ - 1M

E) Working principle - 2M

Constructing Explanation - 3M.

F) Diagram of SEM - 2M

Explanation - 3M

Q.2

A) a) digram of MR setup - 2M

Calculation of formula of μ - 3M

b) Numerical - Given - $\lambda = 5896 \times 10^{-10} m$

$i = 45^{\circ}$

$\mu = 1.33$

Q2 A) (b)

formula :

$$\mu = \frac{\sin i}{\sin r} \Rightarrow \sin r = \frac{\sin i}{\mu} = \frac{\sin 45}{1.33} = 0.5316$$

$$r = 32^\circ 11'.$$

$$\cos r = 0.8470$$

Condition of n^{th} order bright fringe is,

$$2\mu t \cos r = (2n+1)\lambda/2 \qquad n = 0, 1, 2 \cdots$$

$$\therefore t = \frac{\lambda}{4\mu \cos r}$$

for minimum thickness, $n = 1$, $t = t_{min}$

$$t_{min} = \frac{\lambda}{4\mu \cos r} = \frac{5896 \times 10^{-10}}{4 \times 1.33 \times 0.8470}$$

$$t_{min} = 1.308 \times 10^{-7} \text{ m}$$

$$\boxed{t_{min} = 1308 \text{ A}^\circ}$$

B)

a) Diagram of comm system – 2 M

Explanation – 3 M

b) Given – $\Delta = 0.055$

$n_1 = 1.48$

$\lambda = 1 \mu m = 1 \times 10^{-6}$ m

Radius, $a = 50 \mu m = 50 \times 10^{-6}$ m

Formulas – ① $\Delta = \frac{n_1 - n_2}{n_1}$, ② $NA = \sqrt{n_1^2 - n_2^2}$ ③ $NA = \sin i$

Soln –

① $\Delta = \frac{n_1 - n_2}{n_1} \Rightarrow \frac{1.48 - n_2}{1.48} = 0.055$

$$\boxed{n_2 = 1.39}$$

② $NA = \sqrt{n_1^2 - n_2^2} = \boxed{0.50 = NA}$

③ $NA = \sin i$

$i = \sin^{-1}(NA)$

$$\boxed{i = 30^\circ}$$

④ $V = \frac{2\pi a}{\lambda}(NA) = 157$

⑤ $Nm = \frac{V^2}{2} = 12324$

Q2 C)

a) Diagram - 2M

Explanation - 3M

b) Given -

$R_H = 145\ cm^3/C$

$w = 2cm$

$t = 0.2cm$

$B = 2Tesla$

$I = 150mA$

Soln -

① $J = \frac{I}{A} = \frac{I}{w \times d} = \frac{150 \times 10^{-3}}{2 \times 10^{-2} \times 0.2 \times 10^{-2}}$

$J = 3750\ A/m^2$

② $V_H = \frac{BJw}{nc} = R_H \times BJw$

$V_H = 145 \times 10^{-6} \times 3750 \times 2 \times 0.2 \times 10^{-2}$

$\boxed{V_H = 2.175\ mV}$

Q. 2 D). Schrodinger time Indepnd equation - 7M

$E \propto k^2$ - 3M

E) a) Explanation of wave fn - 2M

Significance - 2M

Normalization condn - 1M

b) $V = 900\ m/sec$

Accuracy in speed = $\Delta V = \frac{0.001}{100} \times 900$

$\Delta V = 9 \times 10^{-3}\ m/sec$ (2M)

HUP, $\Delta x \cdot \Delta p_x \geq \hbar = \frac{h}{2\pi}$

$$\Delta x = \frac{h}{2\pi \times \Delta p_x}$$

$$\Delta x = \frac{h}{2\pi \times m\Delta v} \quad \Big| \because \Delta p = m \cdot \Delta v$$

$$\Delta x = \frac{6.63 \times 10^{-34}}{2 \times 3.14 \times 9.1 \times 10^{-31} \times 9 \times 10^{-3}}$$

$$\boxed{\Delta x = 0.01288 \text{ m}}$$

Q. 2 F)

a) SFR - 3M

Explanation of properties } 2 Marks

b) diagram of sol-gel - 2M

Method - 3M.

Q. 3

A) Given - $\mu = 4/3$, $t = 1.5 \times 10^{-4}$ cm

$\lambda = 5 \times 10^{-5}$

Cond^n of dark band, $2\mu t \cos r = n\lambda$

$$n = \frac{2\mu t \cos r}{\lambda}$$

$$\mu = \frac{\sin i}{\sin r} \Rightarrow \sin r = \frac{\sin i}{\mu} = \frac{\sin 45}{4/3} = \frac{1}{\sqrt{2}} \times \frac{3}{4}$$

$$\cos r = \sqrt{1 - \sin^2 r} = \frac{1}{4}\sqrt{\frac{23}{2}}$$

$$n = \frac{2\mu t \cos r}{\lambda} = 6.782$$

$$\boxed{n \approx 6}$$

Q. 3 B) Semiconductor diode

Construction dia - 1M

Energy level dia - 1M

Explanation - 3M.

C) Diagram of n type - 1M

P type - 1M

Explanation n type & P type - 3M

D) Wavepacket defn - 3M

& Explanation

Properties - 2M.

E) Diagram - 2M

Explanation - 3M

F) - Piezzoelectricity - 2M

VDM - 3M.