(Affiliated to University of Mumbai)	***End Semester Examination (R-24) SH 2025 Answer Key with marking scheme***
Branch: EXTC/ECS/CE	Course: Applied Physics
Year/ Semester: 2025-26/I	Course code:FEC1021
Time: 03 hours	Marks: 80

Q1 A) Diagram + Explanation — (2)
Derivation — (2)
conditions — (1)

B) Optical resonator cavity – Diagram + explanation — (3)
– working role — (2)

C) Direct semiconductor — Diagram + explanation — 2½
Indirect semiconductor – ——"—— — 2½

D) $\Delta v = \frac{800 \times 0.01}{100} = 0.08$ m/s — (1)
— (1)

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

$\Delta x = \frac{h}{2\pi m \Delta v} = \frac{6.63 \times 10^{-34}\ J.s}{2\pi \times 0.05 \times 0.08} = 2.62 \times 10^{-32}$ m — (3)

E) 4 + 1
Diagram — (1)
construction, symbol, working — (3)
Dark current — (1)

F) Diagram — (2)
Explanation — (3)

Q2 A) a) Diagram — (1)
Derivation and $\sqrt{nAR}$ — (4)

b) $\beta = \frac{\lambda}{2\mu\theta}$ — (1)
Land $\approx \alpha = \frac{0.06 \times 10^{-3}}{0.15}$ — (1)
$\therefore \beta = \frac{6000 \times 10^{-10} \times 0.15}{2 \times 1 \times 0.06 \times 10^{-3}} = 7.5 \times 10^{-4}$ m or 0.75 mm — (3)

B) a) Modes of OFs — (1) (2)

step index with diagram — (2)

GRSI fibre with diagram — (2)

b) $n_1 = 1.55$, $d = 40\mu m = 40 \times 10^{-6} m$

$n_2 = 1.50$ $\lambda = 1400nm = 1.4 \times 10^{-6} m$

$n_0 = 1$ for air

$$V = \frac{\pi d}{\lambda}\sqrt{n_1^2 - n_2^2}$$

$$= \frac{3.14 \times 40 \times 10^{-6}}{1400 \times 10^{-9}} \sqrt{1.55^2 - 1.50^2}$$

$$= 35$$

No of modes (Nm) $= \frac{V^2}{2} = \frac{35^2}{2} = 612$

C) a) 1+4

Fermi level — (1)

Diagram + Explanation — (4)

b) $n_i = 6.37 \times 10^{19}/m^3$

$\mu_e = 0.38\ m^2/Vs$

$\mu_h = 0.18\ m^2/Vs$

$\sigma = n_i e(\mu_e + \mu_h)$ — (1)

$$\rho = \frac{1}{n_i \cdot e(\mu_e + \mu_h)} = \frac{1}{6.37 \times 10^{19} \times 1.6 \times 10^{-19} \times (0.38 + 0.18)}$$ — (1)

$= 0.4719\ \Omega m$ — (3)

D) a) wave function — (2)

properties — (3)

b) $\lambda = \frac{h}{\sqrt{2mE}}$ — (1) $\lambda = 1A^\circ = 1 \times 10^{-10} m$

$m = 1.67 \times 10^{-27} kg$

$$E = \frac{h^2}{2m\lambda^2} = \frac{(6.63 \times 10^{-34})^2}{2 \times 1.67 \times 10^{-27} \times (1 \times 10^{-10})^2} = \frac{1.31 \times 10^{-20} J}{1.6 \times 10^{-19}} eV$$ — (3)

$= 0.082 eV$ — (1)

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

Statement derivation — (4)

b) (1) Schrodinger eqn derivation — (5)

F) ~~7+3~~
Diagram — (2) (3)
Principle — (1)
Construction — (1)
Working — (3)
Comparision with AFM (3)

Q3 A) 2+3

$$t_{min} = \frac{\lambda}{4\mu t} = \frac{560\times10^{-9}}{4\times2} = 70nm$$ — (3)

Concept of Anti reflection coating — (2)

B) 1+4

Holography — (1)

Any four points differentiations — (4)

C) Derivation with diagram — (4)

$$V_H = \frac{BI}{net}$$

$$R_H = \frac{1}{ne}$$ — (1)

D) $E_n = \frac{n^2h^2}{8mL^2} \Rightarrow E_{(n=1)} = \frac{1^2(6.63\times10^{-34})^2}{8\times9.1\times10^{-31}\times(3\times10^{-10})^2}$ — (3)

$L = 3\times10^{-10}m$

$= \frac{6.69\times10^{-19}}{1.6\times10^{-19}}$ eV

$= 4.17$ eV

$E_{2(n=2)} = 4(E_1) = 16.68$ eV — (1)

$E_{3(n=3)} = 9(E_1) = 37.57$ eV — (1)

E) Diagrams — (2)

Working of RTD — (2)

Use of platinum — (1)

F) $f_1 = \frac{1}{2t_1}\sqrt{\frac{Y}{\rho}} = \frac{1}{2\times1.8\times10^{-3}}\sqrt{\frac{8\times10^{10}}{2650}} = 1.53\times10^6 Hz$ — (2)

$f_2 = \frac{1}{2t_2}\sqrt{\frac{Y}{\rho}}$

$\therefore t_2 = \frac{1}{2f_2}\sqrt{\frac{Y}{\rho}} = \frac{1}{2\times2\times10^6}\sqrt{\frac{8\times10^{10}}{2650}} = 1.37\times10^{-3}m$ — (2)

Difference in thickness

$t_2 - t_1 = 1.8 - 1.37 = 0.43mm$ — (1)