Roll No. 5130

NATIONAL INSTITUTE OF TECHNOLOGY, KURUKSHETRA
FINAL EXAMINATION (B.Tech. 2nd SEM, ECE branch)

Month and year of the examination: **MAY 2024** — Total No of pages used: **02**

Subject and Code: **PHYSICS - II (PHIC 103)**

Maximum Marks: **50** — Time Allowed: **3 Hrs**

- **Attampt All the questions. Write your BRANCH and SUBSECTION at the top of the Answer booklet.**
- Draw relevant, neat and well labelled diagrams wherever necessary. Symbols and constants have their usual meaning.
- Be precise while answering the short questions. Assume suitable parameters and constants, if not given.
- Any Electronic device (except SCIENTIFIC CALCULATER) are strictly prohibited in the duration of the examination.

Useful constants: $\varepsilon_0 = 8.854 \times 10^{-12}$ F.m^{-1}; $k_B = 8.617 \times 10^{-5}$ eVK^{-1}; $h = 4.136 \times 10^{-15}$ eV.s; $m_e = 9.1 \times 10^{-31}$ Kg.

1.

(a) Explain why a semiconductor with a small energy bandgap but having narrow energy bandwidth is an insulator. [2]

(b) Explain with justfcation, why silicon having dimond like crystal structure is opaque but diamond itself is transperant for visible radations. [3]

(c) What is a heterojunction? Using band diagrams show the three possible situations of heterojunction formation. [3]

(d) Calculate the internal pinch off voltage of an n-channel JFET, If the doping concentrations are $N_a = 10^{18}$ cm^{-3} and $N_d = 10^{16}$ cm^{-3}. The channel thickness is a = 0.75 μm. [2]

k = 11.7 → Dielectric const. $\epsilon_s = K\epsilon_0$

2.

Write short notes on (i) E–k diagram, (ii) Brillouin zone schemes and (iii) Effective mass of electrons and holes. [3 + 3 + 4]

OR

(a) In the Kronig-Penney model, $f(\alpha) = P\frac{\sin \alpha a}{\alpha a} + \cos \alpha a = \cos ka$, where $P = \frac{mV_0 ab}{\hbar^2}$, sketch $f(\alpha)$ and discuss the effect of P when (i) $P \to 0$ and (ii) $P \to \infty$. [5]

(b) For the E–k relationship $E = \frac{\hbar^2}{3m}\cos(k)$, preapre a table for effective mass and group velocity for (i) $k = 0$, (ii) $k = \frac{\pi}{2}$, (iii) $k = \pi$, (iv) $k = \frac{3\pi}{2}$, (v) $k = 2\pi$. [5]

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3. Describe details of the experimental technique used for determining the majority carrier concentration in semiconductor. How would you determine the nature of the extrinsic semicondutors using this technique. **[8 + 2]**

OR

(a) What is the physical significance of diffusion coefficient. In n-type GaAs at $T = 300$ K, the electron concentration varies linearly from 1×10^{18} to 7×10^{17} cm^{-3} over a distance of 0.10 cm. Calculate the diffusion current density and mobility if the electron diffusion coefficient is $D_n = 225$ cm^2/s. **[1 + 4]**

(b) Write short notes on Excess carrier generation and recombination mechanims. **[5]**

4. **(a)** Whats is built-in voltage V_{BI}. Deduce the expression of V_{BI} for the case of a **pn** homojunction. How this expression gets modified in the case of (i) p^+n homojunction and (ii) n^+p homojunction **[6]**

(b) Discuss the salient features of "Electron affinity model". Draw the well lablled energy-band diagram of an **nN** heterojunction under equilibrium. **[4]**

5. **(a)** What is the difference between enhancement mode and depletion mode MOSFET? Explain these modes with relevant device design structure. **[3]**

OR

Explain with diagrams, why is the drain current still non zero, when the channel gets pinched off at the drain terminal of a pn JFET. **[3]**

(b) Explain how compound semiconducting materials are considered superior in comparison to the elemental semiconducting materials. **[3]**

(c) What do you mean by channel pinch off. Draw the cross-section and I_D versus V_{DS} curve, when $V_{GS} < V_T$ for (i) small V_{DS}, (ii) larger V_{DS}, (iii) $V_{DS} = V_{DS}(sat)$, and (iv) $V_{DS} > V_{DS}(sat)$. **[4]**

END