

**Time: 2 Hours**

**Marks: 50**

**N.B. :** (1) All questions are **compulsory**.

- (2) **Figures** to the **right** indicate **full** marks.
- (3) Draw **neat** diagrams wherever **necessary**
- (4) Symbols have usual meanings unless otherwise stated.
- (5) Use of **non-programmable** calculator is allowed.

Constants:  $k = 1.38 \times 10^{-23} m^2 kg s^{-2} K^{-1}$

$q = 1.602 \times 10^{-19} C$ ,

$\varepsilon = 8.854 \times 10^{-12} m^{-3} kg^{-1} s^4 A^2$

1. (a) Attempt any **one**:-
  - (i) Classify different types of semiconductors. 7
  - (ii) Describe the Haynes Shockley experiment to demonstrate the drift & diffusion of the minority charge carriers. 7
- (b) Attempt any **one**:-
  - (i) Write a short note on four probe resistivity measurement. 3
  - (ii) With neat band diagram explain direct semiconductors. 3
2. (a) Attempt any **one**:-
  - (i) For a linearly graded p-n junction, show that the built in potential 7

$$V_{bi} = \frac{2kT}{q} \ln \left( \frac{aw_D}{2n_i} \right)$$
  - (ii) Draw and explain the energy band diagram of p-n junction solar cell. Derive the expression for maximum output power of solar cell. 7
- (b) Attempt any **one**:-
  - (i) Explain the operation of a p-i-n diode in short. 3
  - (ii) Write a short note on depletion-capacitance. 3
3. (a) Attempt any **one**:-
  - (i) Draw the energy band diagram of a metal – n type semiconductor contact in thermal equilibrium. Hence find the value of the built in potential  $V_{bi}$ . Explain, how does the energy band diagram gets modified under forward and reverse bias condition? 7
  - (ii) Discuss the switching action of a pnp transistor. Explain how the switching action of the transistor can be improved? 7

- (b) Attempt any **one**:-
- (i) Write short note on quantum well structures. 3
  - (ii) Sketch the minority carrier distribution and state various terms in it for pnp transistor under active mode of operation. 3
4. (a) Attempt any **one**:-
- (i) Explain the MODFET fundamentals. Discuss the energy band diagrams for a MODFET. 7
  - (ii) With the help of sketches of variation of depletion layer width and output characteristics under different biasing conditions, explain the principle of operation of MESFET. 7
- (b) Attempt any **one**:-
- (i) Explain the MOSFET operation using its I-V characteristics. 3
  - (ii) Write note on ideal MOS diode. 3
5. Attempt any **five**:-
- (a) Explain the term surface recombination. 2
  - (b) Give any two applications of Hall effect. 2
  - (c) What is ideality factor? 2
  - (d) Draw and explain the current-voltage characteristics of a tunnel diode. 2
  - (e) Draw the low and high frequency equivalent circuit diagram for pnp transistor connected in CE configuration. 2
  - (f) State the expression of current density in Schottky contact and explain various terms in it. 2
  - (g) For an n- channel GaAs MESFET at  $T = 300\text{K}$  with gold contact, barrier height is  $0.89\text{V}$ . The n- channel doping is  $2 \times 10^{15} \text{ cm}^{-3}$  and the channel thickness is  $0.6\mu\text{m}$ . Calculate the pinch-off voltage and the built-in potential. The dielectric constant of GaAs is 12.4. 2
  - (h) Write note on fabrication of integrated circuit inductor. 2

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