EC-302

SOLID STATE DEVICES

Time Allotted: 3 Hours | Full Marks: 70

The questions are of equal value.
The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

GROUP A
(Multiple Choice Type Questions)

1. Answer any *ten* questions. 10×1 = 10

(i) PIN diode has
(A) p and n layers separated by I layer
(B) p^+ and n^+ layers separated by I layer
(C) p^- and n^- layers separated by I layer
(D) either (B) or (C)

(ii) Under high electric fields, in a semiconductor with increasing electric field
(A) the mobility of charge carriers decrease
(B) the mobility of charge carriers increase
(C) velocity of carriers saturate
(D) both (A) and (C)

(iii) Compared to field effect phototransistors, bi-polar phototransistors are
(A) a more sensitive and faster
(B) more sensitive and slower
(C) less sensitive and slower
(D) less sensitive and faster

(iv) Consider the following statements:
The threshold voltage of MOSFET can be increased by
1.Using a thinner gate oxide.
2. Reducing the substrate concentration
3. Increasing the substrate concentration
(A) 3 alone correct
(B) 1 and 2 correct
(C) 1 and 3 correct
(D) 2 alone correct

(v) Effective mass of electron depends on
(A) curvature of band
(B) band gap
(C) doping concentration
(D) temperature

(vi) Photodetctor diode is
(A) triangular device
(B) square law device
(C) linear device
(D) both (A) and (B)

(vii) Hall voltage is proportional to
(A) velocity
(B) magnetic field
(C) both (A) and (B) parallel to velocity
(D) both (A) and (B) perpendicular to velocity

(viii) Intrinsic carrier concentration of a given semiconductor depends on
(A) bandgap
(B) temperature
(C) bandgap and temperature
(D) none of these

(ix) The ideal barrier height between the metal and the semiconductor of a Schottky barrier diode is
(A) the difference between the metal work function and semiconductor electron affinity.
(B) the difference between the metal work function and semiconductor work function.
(C) the difference between the metal electron affinity and semiconductor work function.
(D) the difference between the metal electron affinity and semiconductor electron affinity.

(x) A transistor configuration with the lowest current gain

(A) common base (B) common emitter
(C) common collector (D) emitter-follower

(xi) Varactor diodes are commonly used

(A) as voltage controlled capacitance
(B) as a constant current source
(C) as voltage multiplier
(D) as a constant voltage source

(xii) Diffusion constant of holes and electrons are in ratio 4:1. Then the mobility of holes and electrons will be in the ratio

(A) 4:1 (B) 16:1
(C) 1:4 (D) 1:16

GROUP B
(Short Answer Type Questions)

Answer any *three* questions. 3×5 = 15

2. Describe briefly the basic structure of a Schottky diode and explain why it is suitable in high frequency operation.

3. With E-K diagram, explain why LED emits light but PN junction rectifier doesn't.

4. What is fill factor? What is the expression for short circuit current and open circuit voltage for solar cell?

5.(a) What is SCR? Point out its major applications.

(b) By using two transistor analogy, briefly describe the basic operation of two terminal SCR.

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6. What is the mass action law for the carrier concentration in a semiconductor? Write down the mathematical expression for Fermi Dirac probability function [$f(E)$] and plot $f(E)$ vs E/E_F for three different temperatures T = 0 K , 300 K , 2000 K and explain it. 2+3

GROUP C
(Long Answer Type Questions)

Answer any *three* questions. 3×15 = 45

7. What is heterojuction? Explain the carrier flow in metal-n-type Schottky diode under forward bias and reverse bias condition. What are the differences between Ohmic contact and Schottky contact? 2+10+3

8. What is meant by direct and indirect semiconductors? Explain with the help of neat diagram and give example of each category. Show that for intrinsic semiconductors, the energy of the Fermi level, $E_f = \frac{E_c + E_v}{2}$, where E_c , E_v are energy of the conduction and valence bands respectively. 2+3+10

9. Draw the V-I characteristic of JFET and explain it. Draw FET small signal model. A JFET has V_p = –4.5 V, I_{Dss} = 10m amp and I_{Ds} = 2.5 mA. Determine the transconductance. 7+8

10.(a) Explain how the junction theory helps to understand the gate control over the channel current. 8+7

(b) Justify the reason of high doping of the gate compared to the channel doping.

11. Write short notes on any *three* of the following: 3×5

(a) Varactor diode
(b) Miller indices
(c) Voltage regulator circuit
(d) Schottky barrier diode
(e) Avalanche and zener mechanism

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