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CS/B.Tech(ECE-New)/SEM-3/EC-302/2013-14
2013
SOLID STATE DEVICES

Time Allotted : 3 Hours | *Full Marks* : 70

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. Choose the correct alternatives for the following : $10 \times 1 = 10$

i) A semiconductor which behaves like an insulator at zero Kelvin is called

a) Intrinsic semiconductor

b) Extrinsic semiconductor

c) Elemental semiconductor

d) Degenerate semiconductor.

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ii) In a semiconductor the hole diffusion length L_p is given by

a) $D_p \tau_p$ b) $(D_p \tau_p)^2$

c) D_p / τ_p d) $\sqrt{(D_p \tau_p)}$.

iii) Solar cell operates in

a) 1st quadrant of I-V plot

b) 2nd quadrant of I-V plot

c) 3rd quadrant of I-V plot

d) 4th quadrant of I-V plot.

iv) LED works on the principle of

a) Photoluminescence

b) Electroluminescence

c) Cathodoluminescence

d) Radioluminescence.

v) Which of the following diodes does not posses a negative differential resistance region ?

a) Tunnel diode b) Gunn diode

c) Zener diode d) IMPATT diode.

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vi) The leakage current I_{CBO} flows through

a) Base and Emitter terminals

b) Emitter and Collector terminals

c) Base and Collector terminals

d) Emitter, Base and Collector terminals.

vii) In a BJT, the base region should be very narrow to minimize the

a) Drift current

b) Diffusion current

c) Recombination current

d) Tunnelling current.

viii) The function of the SiO_2 layer in MOSFETs is to provide

a) High input impedance

b) High output impedance

c) Flow of current carries within channel

d) Both (a) and (b).

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ix) Strong inversion takes place in an n-channel MOSFET when

a) $\Phi_S = 0$ b) $\Phi_S \leq \Phi_F$

c) $\Phi_S = 2\Phi_F$ d) $\Phi_S = \Phi_F$.

x) To turn OFF an SCR, it is necessary to reduce its current to less

a) Trigger current b) Holding current

c) Breakover current d) none of these.

GROUP – B
(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. a) What is density of states ?

b) Explain the plot of Fermi-Dirac distribution function with energy for different temperatures.

c) 3 Volts is applied across a 1-cm long Si bar. Determine mobility when the drift velocity is 10^4 cm/sec.

1 + 2 + 2

3. a) What are mobility and conductivity ?

b) What are the effects of temperature and doping on mobility ? 2 + 3

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4. What is contact potential ? Drive an expression for it. A Si p-n junction diode with doping concentration in p and n-regions 10^{17} cm^{-3} and 5×10^{15} cm^{-3} respectively is in equilibrium.

   Calculate the contact potential for the junction at room temperature. 1 + 4

5. What is meant by *d.c.* operating point or *Q* point in the context of transistor characteristics ? What is load line ? Why is transistor biasing necessary ? 2 + 1 + 2

6. What is early effect ? Explain how the early effect modifies the input current in case of CB and CE configuration of an n-p-n trasistor ? 1 + 4

GROUP – C
(Long Answer Type Questions)
Answer any *three* of the following. 3 × 15 = 45

7. a) Explain the working principle of Zener Diode & its use as a reference voltage device. 10

   b) Calculate the ideality factor (η) of a diode if the diode current increases from 0.40 mA to 10 mA when the applied voltage increases from 0.38 V to 0.48 V at 300K. 5

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8. a) Prove that for an abrupt p-n junction transition capacitance C_T is proportional to $\left(V_0 - V \right)^{-\frac{1}{2}}$, where V_0 is the inbuilt potential and V is applied potential. 6

   b) The depletion layer capacitance of a p-n junction under reverse bias (– 1.0 V) is 5.0 pF. If the built in voltage of the junction is 0.9V. calculate the junction capacitance under 0.5 V forward bias condition. 3

   c) With V-I characteristic curve explain how solar cell delivers power to external load. 4

   d) What are fill factor and conversion efficiency of solar cell ? 2

9. a) Describe briefly the principle of operation of a tunnel diode. Draw the I-V characteristics and mention the –ve resistance region. 5 + 3

   b) What is Thermal runway ? 3

   c) What is Photo Transistor ? 4

10. a) Derive the equation for the different current components in a BJT by Ebers-Moll model. 10

    b) Describe the basic structure of Schottky diode and explain why it is suitable for high frequency operation. 3 + 2

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11. Why is the depletion region tapered near the drain end of a JFET ? With the increase of V_{DS} why complete pinch-off at the drain end does not take place ? Derive an expression for pinch-off voltage of a JFET. From Shockley's equation, find out an expression for the slope of the transfer characteristic of a JFET. Derive an expression for equivalent capacitance for a MOS capacitor. 2 + 2 + 3 + 3 + 5

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