Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech(ECE)/SEM-3/EC-301/2009-10

2009

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 any *ten* of the following : $10 \times 1 = 10$

   i) Si has the lattice patterns of

   a) FCC type b) Hexagonal type

   c) Diamond type d) Zinc blende type.

   ii) Doping effect of semiconductor results with the change of

   a) Fermi level only

   b) Bandgap only

   c) Electrical conductivity only

   d) all of these.

iii) Zener diodes are

a) specially doped *p-n* junction

b) normally doped *p-n* junction

c) lightly doped *p-n* junction

d) none of these.

iv) Diffusion current in a *p-n* junction is influenced by

a) concentration gradient of carriers

b) applied voltage

c) concentration of carriers

d) none of these.

v) The doping level of emitter region of a transistor is

a) greater than collector and base regions

b) less than collector and base regions

c) less than base region but greater than collector region

d) greater than base region but less than collector region.

vi) If a transistor at the middle of the load line is decreasing, the current gain will move the *Q*-point

a) down b) up

c) nowhere d) of the load line.

vii) The output voltage of a CE amplifier is

a) amplified

b) inverted

c) 180° out of phase with the input

d) all of these.

viii) A D-MOSFET can operate in the

a) depletion mode only

b) enhancement mode only

c) depletion mode or enhancement mode

d) low impedance mode.

ix) When a positive voltage is applied to an *n*-type semiconductor with respect to the metal, the barrier between the semiconductor and metal

a) increases b) decreases

c) remains same d) none of these.

x) We can connect photodetector diode in

a) both in forward bias and reverse bias

b) forward bias

c) reverse bias

d) no need to connect in any bias.

xi) IMPATT diode is a

a) negative conductance microwave device

b) high frequency rectifying device

c) low frequency microwave device

d) bulk negative difference conductance device.

xii) Gunn diode is used in

a) microwave oscillator

b) *r.f.* oscillator

c) audio oscillator

d) audio amplifier.

xiii) Varactor diode acts as a

a) variable resistor

b) variable capacitor

c) switching device

d) none of these.

xiv) In *n*-channel MOSFET, source and drain are doped with

a) *n*-type impurity

b) *p*-type impurity

c) source with *p*-type and drain with *n*-type impurity

d) none of these.

xv) BJT is

a) a voltage controlled device

b) a current controlled device

c) a temperature controlled device

d) none of these.

GROUP – B

(Short Answer Type Questions)

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

2. A Si sample is doped with 10^{17} As atoms/cm^3 ($n_i = 1{\cdot}5 \times 10^{10}$). What is the equilibrium hole concentration p_o at 300 K ? Determine the difference between fermi level and intrinsic level. Draw the energy band diagram with proper labels. 2 + 2 + 1

3. Qualitatively discuss the variation of carrier concentration with temperature for extrinnic Si with the help of proper diagram.

4. Derive the steady state diffusion equation for holes in Si. What do you mean by diffusion length ? 4 + 1

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

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

GROUP – C
(Long Answer Type Questions)

Answer any *three* of the following. 3 ∞ 15 = 45

7. a) Derive the expression of junction capacitance for an abrupt *p*-*n* junction.

   b) What do you mean by hyper-abrupt junction ?

   c) Using appropriate circuit and diagram explain the use of a BJT in CE mode as an amplifier. 7 + 3 + (3 + 2)

8. a) Discuss the basic principle of operation and $I_d - V_{ds}$ characteristics of *n*-channel JFET.

   b) Derive the expression of pinch-off voltage for JFET.

   c) Compare the properties of BJT and FET. How do you use JEET as VVR ? 5 + 5 + (3 + 2)

9. Explain transferred electron mechanism with the help of RWH theory. What are the conditions for the occurrence of negative differential resistance in GUNN diode ? Write the applications of GUNN diode. What are the different modes of operations for GUNN oscillator ? 6 + 3 + 2 + 4

10. a) Briefly describe the operation of CMOS inverter. What are the advantages of CMOS ?

    b) With the help of suitable diagram find out the expression of threshold voltage for ideal NMOS.

    c) Find the maximum width of the depletion region for an MOS capacitor on *p*-type Si with $N_a = 10^{16}\ cm^{-3}$.

    (3 + 2) + (2 + 5) + 3

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

    a) Ohmic contact

    b) P-I-N diode

    c) Tunnel diode

    d) MOS capacitance

    e) BJT characteristics

    f) Photolithography.