Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech(ECE-N)/SEM-3/EC-302/2011-12

2011

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 × 1 = 10

   i) If a voltmeter is connected across the terminal of an unbiased Germanium *p-n* junction diode, the voltmeter reading will be
      a) 0 V b) 0·3 V
      c) 0·6 V d) 1·0 V.

   ii) The capacitance of a varactor diode can be changed by varying
      a) bias voltage b) doping level
      c) size of the diode d) all of these.

   iii) Which of the following diodes does not possess a negative resistance region in its characteristics ?
      a) Tunnel diode b) Gunn diode
      c) Zener diode d) IMPATT diode.

   iv) At T = oK, the Fermi-Dirac distribution function *vs* energy plot takes the form ..... .
      a) step b) linear
      c) parabolic d) exponential.

v) If ϕ_s and ϕ_F denotes respectively the surface and Fermi potential, strong inversion takes place in an *n*-channel MOSFET when

a) $\phi_s = 0$ b) $\phi_s < \phi_F$

c) $\phi_s = \phi_F$ d) $\phi_s = 2\phi_F$.

vi) The basic lattice structure of silicon is

a) simple cubic b) edge-centered cubic

c) face-centered cubic d) body-centered cubic.

vii) GaAs is preferred to Si for high temperature operation of semi-conductor device because GaAs

a) is direct band gap in nature

b) possesses higher energy band gap

c) is a compound semi-conductor

d) possesses smaller carrier effective mass.

viii) A bipolar junction transistor, when used as a switch, operates in

a) cut-off and active region

b) active and saturation region

c) cut-off and saturation region

d) all of these.

ix) The quadrant of I-V plot relevant to operation of a solar cell is

a) 1st b) 2nd

c) 3rd d) 4th.

x) Tunnel diode is used in

a) audio oscillator b) r.f. oscillator

c) microwave oscillator d) mm-wave oscillator.

xi) A voltage variable capacitance can be realized in

a) Zener diode b) Avalanche diode

c) Schottky diode d) Varactor diode.

xii) A BJT used in CE configuration offers

a) low input impedance and high output impedance

b) high input impedance and low output impedance

c) low input and output impedances

d) high input and output impedances.

GROUP – B
(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. What are direct band gap and indirect band gap semi-conductors ? Draw the E - K diagrams for Si and GaAs. 3 + 2

3. What is ambipolar transport ? Why carrier generation and recombination rates are equal in thermal equilibrium ? 2 + 3

4. What is contact potential ? Derive an expression for it involving impurity concentration on either side of the structure. 2 + 3

5. Define mobility and write down its unit. Also give an equation that relates the mobility and diffusivity of carriers in a semi-conductor. What is the significance of the equation ? 1 + 1 + 2 + 1

6. What do you mean by Pinch-off condition in JFET ? Briefly describe the situation. 2 + 3

GROUP – C
(Long Answer Type Questions)

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

7. a) What is 'law of mass action' ? Explain its significance. 4

b) Describe different breakdown mechanisms that may occur in a reverse biased semi-conductor *p-n* junction diode. 11

8. a) With the help of energy band diagram, describe formation of Schottky barrier at the junction between a metal and an *n*-type semi-conductor. Explain why a Schottky diode is faster than a *p-n* junction diode. 6 + 2

   b) Describe the origin of 'diffusion capacitance' and 'depletion capacitance' in a *p-n* junction. Also discuss their dependence on the biasing condition of the diode. 5 + 2

9. a) What is early effect ? Explain how it influences the input characteristics of a BJT in CB configuration. 3 + 3

   b) Draw the output characteristics of a BJT used in CB configuration. Indicate different regions in the characteristics and explain them. 3 + 6

10. a) With the help of energy band diagram, explain the I-V characteristics of a tunnel diode. 7

    b) Describe operation of a *pnpn*-structure on the basis of two-transistor analogy. 4

    c) Sketch the transfer characteristics of a depletion MOSFET operated in both depletion mode and enhancement mode. 4

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

    a) Solar cell

    b) Hall effect

    c) Effective mass

    d) PIN photodiode

    e) Gunn diode.