

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 : $10 \times 1 = 10$
 - 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
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 ?
 - 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.

a)

[Turn over

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



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.

3154(N)

2

- CS/B.Tech(ECE-N)/SEM-3/EC-302/2011-12
- 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. $3 \times 5 = 15$

- 2. What are direct band gap and indirect band gap semiconductors? 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. $3 \times 15 = 45$

- 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

3154(N)

[Turn over



- 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.
- 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.

4