Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech(ECE)/SEM-3/EC-301/2010-11

2010-11

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) Reverse saturation current of *p-n* junction diode is

a) diffusion current b) drift current

c) displacement current d) none of these.

ii) Tunnel diode is used in

a) microwave oscillator b) r.f. oscillator

c) audio oscillator d) video amplifier.

iii) Electron effective mass depends on

a) curvature of band b) band gap

c) doping concentration d) temperature

iv) Ion implantation is done

a) at lower temperature compared to diffusion

b) at higher temperature compared to diffusion

c) at most same temperature as diffusion

d) none of these.

v) A varactor diode is operated under

a) reverse bias b) forward bias

c) without bias d) zero bias.

vi) Which of the following has a negative resistance region ?

a) Zener diode b) Tunnel diode

c) Photodiode d) LED.

vii) In GaAs when the electron rises from central valley to satellite valley, the effective mass of electron becomes

a) less b) more

c) zero d) infinity.

viii) 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.

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) Flat band condition in an MOS capacitor occurs when

a) $\Phi_s = 0$ b) $\Phi_s > 0$

c) $\Phi_s < 0$ d) $\Phi_s = \Phi_F$.

xii) Inversion layer in an MOS device can be created by
   a) doping b) impact ionization
   c) tunnelling d) electric field.

xiii) In photodiode, *E-H* pairs are generated, when energy of incident photo should be ?
   a) $hf < Eg$ b) $hf > Eg$
   c) $hf = Eg$ d) $hf >> Eg$.

xiv) Solar cell operates in
   a) 1st quadrant of I-V chart
   b) 4th quadrant of I-V chart
   c) 2nd quadrant of I-V chart
   d) 3rd quadrant of I-V chart.

xv) Avalanche breakdown primarily depends on the phenomenon of
   a) impact ionization b) field ionization
   c) particle collision d) impurity doping.

GROUP – B
(Short Answer Type Questions)

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

2. Sketch the ideal energy band diagram of metal-semiconductor junction when $\phi M < \phi S$. Explain why this is ohmic contact.

3. What do you mean by effective mass ? Derive the expression of effective mass. How can effective mass differ from actual mass and in which condition effective mass will be positive, negative and infinity ?

4. a) Define step graded junction and linearly graded junction.
   b) Define diffusion capacitance and transition capacitance.

5. What is degenerate semiconductor ? Draw the volt-ampere characteristics of tunnel diode and explain the occurrence of negative differential resistance in characteristics.

6. What is early effect ? Define punch through in early effect.

GROUP – C

(Long Answer Type Questions)

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

7. a) What is photovoltaic effect ?

   b) Write down the operating principle of solar cell. Derive the expression for V_{oc} .

   c) What are quantum efficiency and responsivity ?

   2 + 3 + 10

8. a) Draw the basic structure of a read diode and discuss the basic principles of the operation of IMPATT diode.

   b) Explain transferred electron mechanism of the bulk negative differential conductivity exhibited by Gunn diode and mention its application. 7 + 8

9. a) Sketch the energy band diagram of MOS capacitor with an *n*-type substrate in accumulatin, depletion and inversion modes.

   b) What is the total capacitance of an MOS capacitor ? How does it vary with voltage ?

   c) Derive an expression for threshold voltage of an ideal MOSFET. 5 + 4 + 6

10. a) Derive the expression for the current flowing across a *p-n* junction.

    b) Define diffusion capacitance and storage capacitance in *p-n* junction. 10 + 5

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

    a) Varactor diode

    b) Miller indices

    c) Photolithography

    d) Voltage regulator circuit

    e) Schottky barrier diode.