

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.

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- 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) $\Phi_s = \Phi_F$.

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- 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) $hf < E_g$
 - b) $hf > E_g$
 - c) $hf = E_g$
 - d) $hf \gg E_g$.
- 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. $3 \times 5 = 15$

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.

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GROUP - C**(Long Answer Type Questions)**Answer any *three* of the following. $3 \times 15 = 45$

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 accumulation, 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.