



**MAULANA ABUL KALAM AZAD UNIVERSITY OF
TECHNOLOGY, WEST BENGAL**

Paper Code : EC-302

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) Energy bandgap of GaAs at 0 K is
 - a) 1.12 eV b) 0.66 eV
 - c) 1.43 eV d) 3.40 eV.
- ii) According to the $E-k$ diagram, Si is
 - a) direct bandgap b) indirect bandgap
 - c) both (a) and (b) d) none of these.
- iii) Boltzmann approximation is valid for
 - a) higher energy states b) lower energy states
 - c) both (a) and (b) d) None of these.

- iv) Under forward bias, $p-n$ junction current flows mainly due to
 - a) diffusion b) drift
 - c) both (a) and (b) d) none of these.
- v) Intrinsic Fermi level (E_{Fi}) will be slightly above the midgap energy level (E_{midgap}), if
 - a) $m_p^* > m_n^*$ b) $m_p^* < m_n^*$
 - c) $m_p^* = m_n^*$ d) any one of these.
- vi) Flat-Band voltage of n-channel enhancement type MOSFET is
 - a) positive b) negative
 - c) positive or negative d) zero.
- vii) Which one of the following is not a voltage controlled device ?
 - a) MOSFET b) IGBT
 - c) BJT d) JFET.
- viii) Pinch-off voltage of FET depends on
 - a) channel width
 - b) doping concentration of channel
 - c) applied voltage
 - d) both of (a) and (b).
- ix) For design of high speed electronic system the preferred one should be
 - a) Si n -MOS b) Si p -MOS
 - c) GaAs n -MOS d) GaAs p -MOS.
- x) Which of the following is not a negative resistance device ?
 - a) Zener diode b) IMPATT diode
 - c) Gunn diode d) LED.

- xi) 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.

GROUP – B

(Short Answer Type Questions)

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

2. What do you mean by effective mass ? Derive the expression for effective mass. How can effective mass differ from actual mass and in which condition effective mass will be positive, negative and infinity ?
3. What is degenerate semiconductor (explain with band diagram) ? Draw the I-V characteristic of a Tunnel diode and explain the occurrence of negative differential resistance in the I-V characteristics.
4. What is early effect ? Explain how the early effect modifies the input current in case of CB and CE configuration of an $n-p-n$ transistor ?
5. a) Define step graded and linearly graded junction.
b) Define diffusion capacitance and transition capacitance.
6. a) What is fill factor ?
b) Derive the expression for short circuit current and open circuit voltage for the solar cell. $2 + 3$

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) Explain the working principle of a Zener diode and its use as a reference voltage device.
b) What is the difference between step graded and linearly graded semiconductor PN junction ?
c) Define diffusion capacitance and storage capacitance in PN junction. $5 + 5 + 5$
8. a) What is photovoltaic effect ?
b) What are quantum efficiency and responsivity ?
c) Write down the basic operating principle of solar cell. derive the expression for VOC. $5 + 5 + 5$
9. a) What do you mean by MOS capacitor ?
b) Draw the $C - V$ dependence curve and specify the three different region in the graph.
c) Define flat band voltage with respect to MOS devices. $5 + 5 + 5$
10. a) Explain band bending and channel inversion in case of n channel enhancement type MOSFET.
b) What is channel length modulation ?
c) Determine the probability of occupancy of a state that is located at 0.359 eV above E_F at $T = 300$ K. $8 + 4 + 3$
11. Write short notes on any *three* of the following : $3 \times 5 = 15$
 - a) SCR
 - b) Diode Switching
 - c) Tunnel diode
 - d) TRIAC
 - e) Diode Capacitance.