



CS/B.TECH(ECE)/SEM-3/EC-301/06

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ENGINEERING & MANAGEMENT EXAMINATIONS, DECEMBER - 2006
SOLID STATE DEVICES
SEMESTER - 3

Time : 3 Hours]

[Full Marks

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer Questions No. 1 and any four from the rest.

1. Select the correct answer of the following : 10 × 1 =
- i) Intrinsic carrier concentration of a given semiconductor depends on
 - a) bandgap
 - b) temperature
 - c) bandgap and temperature
 - d) none of these.
 - ii) GaAs is preferred to Si in high frequency devices because of
 - a) higher bandgap
 - b) lower effective mass
 - c) direct energy bandgap
 - d) none of these.
 - iii) Diffusion current exists in
 - a) semiconductor
 - b) insulator
 - c) metal
 - d) metal and insulator.
 - iv) Concentration of minority carriers in any extrinsic semiconductor under equilibrium is
 - a) directly proportional to the doping concentration
 - b) inversely proportional to the doping concentration
 - c) directly proportional to intrinsic carrier concentration
 - d) inversely proportional to intrinsic carrier concentration.
 - v) Gunn effect is observed in
 - a) Si p-n junction diode
 - b) GaAs p-n junction diode
 - c) Ge p-n-p transistor
 - d) Si JFET.
 - vi) Majority carriers of ~~any~~ type semiconductor are
 - a) protons
 - b) electrons
 - c) holes
 - d) neutrons



- vii) If the barrier potential is increased in any $p - n$ junction then the width of the junction will
- remain unaltered
 - increase proportional to square root of the potential
 - increase linearly
 - decrease proportional to square of the potential.
- viii) Varactor diode act as
- variable resistor
 - variable capacitor
 - switching device
 - none of these.
- ix) In n -channel MOSFET, source and drain are doped with
- n -type impurity
 - p -type impurity
 - source with p -type and drain with n -type impurity
 - none of these.
- x) BJT is
- a voltage controlled device
 - a current controlled device
 - a temperature controlled device
 - none of these.
2. a) Draw the $E - K$ diagrams for Si and GaAs and comment on specific applications from the nature of the diagram. 5
- b) Write an expression for conductivity in terms of carrier concentration, mobility etc. What is understood by carrier relaxation time and how mobility is related with temperature and carrier relaxation time? 2 + 2 + 1
- c) Draw the $I - V$ characteristics of a $p - n$ junction diode under reverse and forward bias. What is understood by ideality factor and reverse voltage breakdown? 2 + 3
3. a) Sketch the cross-sectional view of a p -channel MOSFET with proper labels. 5
- b) Define
- flatband voltage and
 - capacitance of MOS devices. 3 + 2
- c) Derive and expression for the threshold voltage of an ideal MOSFET. 5



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4. a) Derive expression for the current flowing across a $p - n$ junction due to drift and diffusion. 7
- b) What is punch through breakdown in BJT ? Derive a relationship between I_{CO} and I_{CBO} and discuss their effects on temperature. 4 + 4
5. a) Explain the physical mechanism of current conduction in BJT. Draw the characteristics for common base operation. Derive a relationship between α , β and γ . 5 + 3 + 2
- b) Why h -parameters are not used for transistor model at high frequency ? Comment on the doping level and dimensions of Emitter, Base and Collector of BJT. 2 + 3
6. What is understood by depletion mode and enhancement mode MOSFET ? For a switch operation how these devices are connected ? Draw the $I_D - V_{DS}$ characteristics for each of them and explain for saturation in the nature of the characteristics. 3 + 4 + (4 + 4)
7. a) What are the basic conditions of tunneling in a $p - n$ junction diode ?
- b) Draw the complete $V - I$ characteristics of a tunnel diode and explain.
- c) Show the negative differential resistance region.
- d) Mention two applications where tunnel diode may be used. 2 + (2 + 7) + 2 + 2
8. Write short notes on any *three* of the following : 3 × 5
- a) Schottky Barrier Diode
- b) PIN photo detector
- c) Light emitting diode
- d) Photolithography
- e) Miller indices.
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