



ENGINEERING & MANAGEMENT EXAMINATIONS, JUNE - 2009
MICROELECTRONICS & OPTO-ELECTRONIC DEVICES
SEMESTER - 4

Time : 3 Hours]

[Full Marks : 70

GROUP - A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : 10 × 1 = 10
- i) Bilateral switch is
- | | |
|--------------|--|
| a) DIAC | b) IGBT |
| c) Thyristor | d) none of these. <input style="float: right;" type="checkbox"/> |
- ii) The condition, where the majority carrier concentration is greater near the Si-SiO₂ interface compared to the bulk in the MOSFET is called
- | | |
|-----------------|--|
| a) Accumulation | b) Depletion |
| c) Inversion | d) None of these. <input style="float: right;" type="checkbox"/> |
- iii) Electron affinity depends on
- | | |
|---------------------------|--|
| a) semiconductor material | b) doping of semiconductor |
| c) applied potential | d) none of these. <input style="float: right;" type="checkbox"/> |
- iv) The radiative and non-radiative life time of an LED are 2.5 ms and 60 ms respectively. The internal quantum efficiency is
- | | |
|---------|---|
| a) 96% | b) 24% |
| c) 100% | d) 104%. <input style="float: right;" type="checkbox"/> |



v) Photodetector is a

- a) triangular device b) square low device
c) linear device d) both (a) and (b).

vi) Which of the following pairs are suitable for making a heterojunction ?

- a) Si & Ge b) Si & GaAs
c) GaAs & AlAs d) GaAs & GaAlAs.

vii) Metal *n*-type semiconductor form ohmic contact if

- a) $\phi_m > \phi_{sn}$ b) $\phi_m = \phi_{sn}$
c) $\phi_m < \phi_{sn}$ d) none of these.

viii) In charge transfer devices, charge can be transferred

- a) in any direction b) in a predetermined direction
c) by diffusion process d) with the help of electric field.

ix) In *P-I-N* diode the *I* part refers to

- a) extrinsic substrate b) intrinsic substrate
c) intrinsic semiconductor d) extrinsic semiconductor.

x) MEMS actuators are devices which is capable to

- a) convert mechanical strain into electrical O/P
b) convert electrical I/P into mechanical movement
c) convert both from mechanical I/P to electrical O/P and vice versa
d) convert any form of input energy to mechanical energy.

xi) When BJT works as an amplifier its operation is confined to

- a) Cut-off region b) Saturation region
c) Active region d) Both (a) and (b).



- xii) The equivalent circuit of an IGBT consists of
- two bipolar transistors
 - two MOS transistors
 - one MOS transistor and one bipolar transistor
 - two bipolar transistors with one MOS transistor.



GROUP - B

(Short Answer Type Questions)

Answer any three of the following questions.

3 × 5 = 15

- What is SCR ? Point out its major uses.
 - By using two transistor analogy, briefly describe the basic operation of two terminal SCR.
- What is the disadvantage of lateral DMOS structure ? Why VDMOS has higher packing density than LDOS ?
- What is population inversion ? The population in two energy levels E_1 & E_2 are N_1 & N_2 respectively. Express the ratio N_1 / N_2 under normal condition assuming Boltzman statistics.
- What is ambipolar transport ? Why carrier generation and recombination rate are same in thermal equilibrium ?
- What is dynamic effects in MOS capacitors ? What are the applications of CCD ?

2 + 3

$2 \frac{1}{2} + 2 \frac{1}{2}$

3 + 2

3 + 2

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

7. a) What are the differences between Schottky junction diode and normal $p-n$ junction diode ?
- b) With energy band diagram describe Schottky junction barrier formation. Describe its operation under external bias.
- c) What is semiconductor heterojunction ? Point out the classification of the same.
- d) A Schottky diode made from tungsten and n -type Si with doping $N_d = 10^{16} \text{ cm}^{-3}$. If the work functions of the metal is 4.55 V and Si electron affinity is 4.01 V, calculate
- barrier height
 - built-in potential barrier
 - space charge with and
 - maximum electric field
- at the junction under zero applied bias at $T = 300 \text{ K}$.

 $2 + (2 + 3) + (2 + 2) + 4$

8. a) What is MEMS ?
- b) What is micromachining technique ?
- c) Discuss in detail about different micromachining techniques.
- d) Discuss the photolithography process in connection with VLSI technology.

 $1 + 1 + 9 + 4$



9. a) Distinguish between direct and indirect band-gap materials. Which one is useful for the design of optoelectronic devices and why ?
- b) What are the advantages of LASER over LED ?
- c) With diagram, explain briefly the operation of semiconductor laser.
- d) An optical intensity of 10 W/cm^2 at $\lambda \sim 0.75 \mu\text{m}$ is allowed to incident on a GaAs based photodetector. Calculate the carrier generation rate at 300 K. For GaAs, $\alpha \sim 7 \times 10^3 \text{ cm}^{-1}$ and $E_g \sim 1.43 \text{ eV}$. $(2 + 2) + 2 + (2 + 4) + 3$
10. a) Explain the operation of CMOS as an inverter with circuit diagram.
- b) How does CCD act practically in single phase and two phase arrangements ?
- c) Describe the operation of insulated gate bipolar junction transistor (IGBT) with basic structure. $5 + (3 + 2) + 5$
11. Write short note on any *three* of the following : 3×5
- a) MEMS pressure sensor
- b) OEIC
- c) 2D electron gas
- d) Solar cell
- e) MOSFET scaling.

END