M.TECH/ECE(VLSI)/1ST SEM/VLSI 5103/2016

MICROELECTRONICS TECHNOLOGY AND IC FABRICATION
(VLSI 5103)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.

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

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) The diffusion constant of the following impurity in SiO_2 at 1100^0C is maximum for
(a) Boron (b) Phosphorous
(c) Arsenic (d) Gallium.

(ii) The process of deposition of silicon dioxide by reaction with dicholorosilane ($SiCl_2H_2$) with nitrous oxide at reduced pressure is carried out at a temperature (in ^{0} C) of
(a) 450 (b) 600 (c) 700 (d) 900.

(iii) The most common liquid source for boron is
(a) trimethyl borate (b) boron tribromide
(c) diborane (d) none of the above.

(iv) Which of the following materials have a higher Projected Range for ion implantation in silicon at 100keV implantation energy?
(a) Arsenic (b) Phosphorous
(c) Boron (d) Zinc.

(v) Which of the following processes is used to form a deep junction?
(a) Ion implantation (b) Diffusion
(c) Etching (d) Oxidation.

(vi) Both gate and field oxides, are generally grown by the process of
(a) electrochemical anodization (b) plasma-enhanced CVD
(c) thermal oxidation (d)none of these.

(vii) The barrier materials typically used to stop copper diffusion in Damascene technology is
(a) Platinum (Pt) (b) Palladium (Pd)
(c) TaN (d) Chromium (Cr).

(viii) Which one of the following materials has the lowest bulk resistivity?
(a) Au (b) Al (c) W (d) Cu.

(ix) The Chemical Vapour Deposition (CVD) for Silicon is typically carried out by using the most widely used resource
(a) Silane (SiH_4) (b) Silicon Tetra chloride($SiCl_4$)
(c) Dichlorosilane (SiH_2Cl_2) (d) Trichlorosilane ($SiHCl_3$).

(x) Interconnections and ohmic contacts are formed in
(a) diffusion process (b) ion implantation process
(c) etching process (d) metallization process.

Group – B

2. (a) What do you understand by the term "Thermal Oxidation"? Draw the schematic cross-sectional diagram of a resistance heated oxidation furnace and discuss its operating principles.

(b) The molecular weight is 28.8 gm/mol and density is 2.328 gm/cc for Si and molecular weight is 60 gm/mol and density is 2.213 gm/cc for SiO_2. Find the thickness of silicon consumed for growth of 100 nm of SiO_2?

6 + 6 = 12

3. (a) What is meant by "Diffusion in Semiconductors"? Draw the schematic diagram of of a typical open tube diffusion system and explain its principles of operation.

(b) Discuss the terms "vacancy diffusion" and "interstitial diffusion "with suitable diagrams.

(c) What is Fick's diffusion equation? Find the solution of the equation for constant total dopant conditions.

4 + 4 + 4 = 12

Group – C

4. (a) Discuss with suitable schematic diagrams, the ion implantation method for implanting ions in silicon using a suitable ion implanter.

(b) Explain what do you understand by “Projected Range” and “Projected Straggle”.

(c) Draw the variation of concentration with depth for ion implantation in silicon. What is "ion channelling"?

4 + 4 + 4 = 12

5. (a) Discuss the different types of charges that exist at or near the Si-SiO_2 interface of a MOSFET and how these might affect the device performance.

(b) What is bird’s beak?

10 + 2 = 12

Group – D

6. (a) Discuss the advantages of doping using ion implantation method over the diffusion method.

(b) Draw a schematic diagram of an ion-implantation system and explain its basic principle of operation.

4 + 8 = 12

7. (a) What is a photoresist? What are its properties?

(b) Discuss the different exposure methods used in optical lithography.

(1 + 2) + 9 = 12

Group – E

8. (a) State the principal limitations of conventional lithography. How are these overcome in electron-beam lithography?

(b) Write short notes on the following:
(i) Reactive Ion Etch
(ii) Multi-level metallization

(2 + 2) + (4 + 4) = 12

9. (a) What is epitaxy? Why is epitaxial growth necessary during device fabrication?

(b) Discuss the sputtering technique of film deposition.

4 + 8 = 12