Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
Manipal University

FIRST SEMESTER M.TECH (ME) DEGREE END SEMESTER EXAMINATION
NOV/DEC 2015
SUBJECT: VLSI PROCESS TECHNOLOGY (ECE - 523)

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to candidates
- Answer **ANY FIVE** full questions.
- Missing data may be suitably assumed.

1A. In a two-step process phosphorous is diffused into p-type silicon wafer, with $N_B = 10^{16}/cm^3$. In the step deposition, the temperature was 900°C and diffusion time is 45 minutes. In the drive in step, the temperature was 1100°C and the time is 60 minutes. Find surface concentration and the junction depth. Given that activation energy for the process is 3.68 eV and solid solubility of phosphorous in silicon at 900°C is $7 \times 10^{20}/cm^3$ and $D_o = 4.70\ cm^2/Sec$.

1B. At what temperature the Ga and As vacancy concentrations will be same in GaAs. Given that the activation energies for Ga and As vacancy formation are 0.4 eV and 0.7 eV respectively.

[6+4]

2A. Find the concentration of phosphorous atoms in the melt to obtain Si doped with $10^{16}/cm^3$.Given that K_d for phosphorous in Silicon is 0.35 and $Z_P = 31$ grams and density of Si is 2.33 grams/cm^3. How many grams of P should be added in the initial load in the crucible is 5Kg of Si.

2B. A silicon wafer is doped p-type at a concentration of $10^{20}/cm^3$. At 1000°C positively charged vacancy concentration is $5 \times 10^{11}/cm^3$. Find the energy level of singly positively charged vacancy with respect to intrinsic energy level. Given that the activation energy of formation of vacancy is 2.6 eV and intrinsic carrier concentration is $10^{19}/cm^3$.

(5+5)

3A. What is approximate oxide thickness after 100 minute dry oxidation and followed by 35 minute wet oxidation at 900 °C. Given that: For dry oxidation – B/A = 0.016 μm / hour and B= 0.004μm^2 / hour. And for wet oxidation B/A = 0.255 μm/hour and B= 0.172 μm^2/hour. Ignore initial fast oxidation regime.

3B. Explain limitation of CV measurement technique in determining the diffusion profiles of dopant atoms.

(6+4)

4A. A wafer is heated to 1100 °C and exposed to high concentration source of Arsenic. After 5 minutes, the wafer is removed from the source and surface is sealed and then annealed at 1200 °C for 6 hours. Assume intrinsic diffusion. Find

i) Q_T

ii) The final profile and iii) Junction depth if the wafer were initially doped $1 \times 10^{15}/cm^3$. It can be assumed that surface concentration is solid solubility, i.e., $2 \times 10^{21}/cm^3$. Further $D = 3.2 \times 10^{-14}\ cm^2/sec.$ at 1100°C and $D = 2.8 \times 10^{-13}\ cm^2/sec.$ at 1200 °C.

4B. Explain the emitter push effect in n-p-n bipolar transistors.

(7+3)

5A. . Justify the following with suitable explanation

i) Phosphorous is commonly used in to form deep junctions in CMOS devices.

ii) Low pressure CVD is kinetically controlled while atmospheric CVD is equilibrium controlled.

iii) Electric and Magnetic fields are utilised in producing high density plasma.

5B. Explain how Fick's law is modified in the presence of internal electric field in the substrate.

(3+3+4)

6A . Explain the various steps involved in vapour phase epitaxy.

6B Explain various wafer cleaning processes before growth in vapour phase epitaxy.

(5+5)

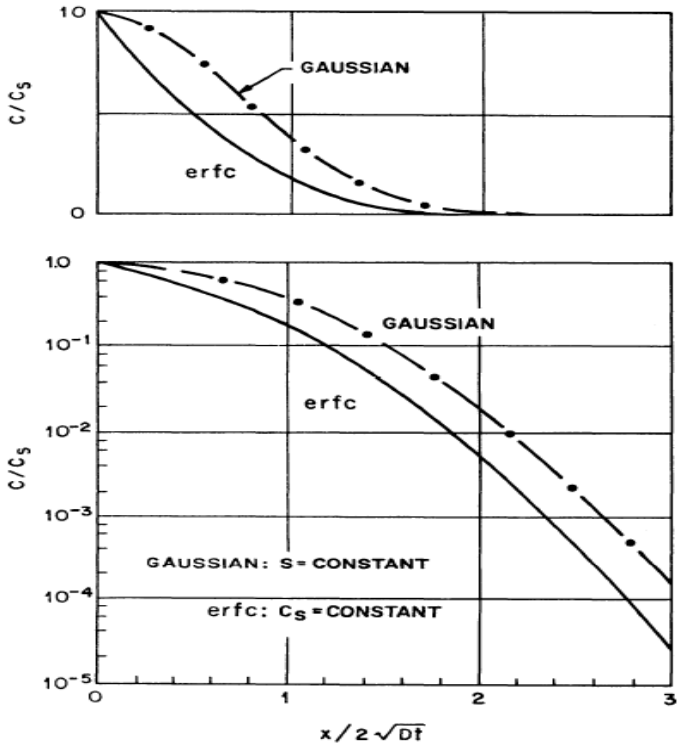

Figure : Normalised concentration verses normalised distance for erfc and Gaussian functions.