Dec Ne					
Keg. No.					
100					



MANIPAL INSTITUTE OF TECHNOLOGY Manipal University

FIFTH SEMESTER B.TECH (E & C) DEGREE END SEMESTER EXAMINATION NOV/DEC 2015 SUBJECT: VLSI PROCESS TECHNOLOGY (ECE - 323)

TIME: 3 HOURS

MAX. MARKS: 50

- Instructions to candidates

 Answer ANY FIVE full questions.
 Missing data may be suitably assumed.

 1A. Identify the type of etching done for silicon in each case in Fig 1A. Explain the basic processes involved in Plasma etching of silicon.
 - 1B. Explain the fabrication of polysilicon film resistor with neat diagram.
 - 2A. Derive the equation for doping distribution function of fraction solidified in CZ process. Suppose your company was in the business of producing silicon wafers for the semiconductor industry by the CZ growth process. Suppose you had to produce the maximum number of wafers per boule that met a fairly tight resistivity specification. Would you prefer to grow N type or P type crystals? Why?
 - 2B. Explain the basic set-up of ion implanter system.

(6+4)

3A. Determine the final SiO2 thickness for the following wafer (Assume initial oxide thickness is 0). Repeat the same for <100> crystal. Use Table 3A. Wafer A: <111> oriented Si substrate
1st step: dry oxidation
temperature = 1050 °C; pressure = 1 atmosphere; time = 30 minutes.
2nd step: wet oxidation
temperature = 1100 °C; pressure = 1 atmosphere; time = 30 minutes.

3B. Explain the e-beam evaporation process with neat diagram

(6+4)

- 4A. Explain the constant-Total dopant diffusions. A constant-source boron diffusion is performed into an n-type silicon wafer. The diffusion temperature is 1050°C and the diffusion time is 1 hour. Assume that the surface concentration is limited by the solid solubility limit. If the n-type background doping of the silicon is $5x10^{16}$ cm⁻³, find the junction depth. Given Do= 1 cm²/s, Ea=3.5eV, $Ns \approx 2.4x10^{20}$ cm⁻³, k_B=8.617x10⁻⁵ eV/K, erf(2.63)=0.9998
- 4B. Plot resolution and depth of field as a function of exposure wavelength for a projection aligner with $100 \text{nm} < \lambda < 500 \text{nm}$ in step of 100 nm. Assume NA = 0.26. Discuss the implication of these plots for the technologist that must manufacture transistors with $0.5 \mu m$ features. Given ArF DUV= 193 nm.

(6+4)

- 5A. Arsenic is implanted into a lightly doped p-type Si substrate at an energy of 75keV. The dose is 1×10^{14} / cm². The Si substrate is tilted 7° with respect to the ion beam to make it appear amorphous. The implanted region is assumed to be rapidly annealed so that complete electrical activation is achieved. What is the peak electron concentration produced? Given $R_P = 0.05 \mu m$ $\Delta R_P = 0.02 \mu m$. List three advantages of ion implantation over diffusion.
- 5B. Explain the fabrication of MOS capacitor with neat diagram.
- 6A. Sketch following (i) (3-1-2) (ii) [12-2] (iii) (11-3) (iv) [-2-21]
- 6B. Explain homoepitaxy and heteroepitaxy with an example.

(6+4)

(6+4)



Oxidation temperature (°C)	Wet oxidation	on	Dry oxidation		
	A (μm)	$B \ (\mu m^2/hr)$	A (μm)	B (μm ² /hr)	
1200	0.05	0.720	0.04	0.045	
1100	0.11	0.510	0.09	0.027	
1000	0.226	0.287	0.165	0.0117	
920	0.50	0.203	0.235	0.0049	
800			0.37	0.0011	

Table 1. Wet and dry oxidation of Silicon