Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

SIXTH SEMESTER B.TECH. (E & C) DEGREE END SEMESTER EXAMINATION
JUNE 2019
SUBJECT: VLSI/ULSI PROCESS TECHNOLOGY (ECE - 4016)

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

Instructions to candidates
- Answer **ALL** questions.
- Missing data may be suitably assumed.

1A. Explain the silicide process with neat diagram.

1B. Discuss metallization process for the case of aluminium.

1C. Explain damascene process of copper metallizations.

(4+3+3)

2A. Explain the molecular beam epitaxy with neat diagram.

2B. Sketch the following within the unit cubic cell (321) and (102).

2C. A Czochralski crystal is pulled from a melt containing 10^{15} cm^{-3} boron and $2x10^{14}$ cm^{-3} phosphorus. (Initially the crystal will be P type but as it is pulled, more and more phosphorus will build up in the liquid because of segregation. At some point the crystal will become N type.) Assuming k_O = 0.32 for phosphorus and 0.8 for boron, calculate the distance along the pulled crystal at which the transition from P to N type takes place.

(4+3+3)

3A. A boron diffusion into a 1-ohm-cm n-type wafer results in a Gaussian profile with a surface concentration of 5×10^{18} cm-3 and a junction depth of 4μm. N_B=$4.5\times10^{15} cm^{-3}$, D_B=10.5, Ea=3.69 eV.

(i). How long the diffusion will take place if the diffusion temperature is 1100°C.

(ii). What was the sheet resistance of the layer? (use Surface impurity concentration versus sheet-resistance-junction depth product graph).

(iii). Calculate the dose in the layer.

3B. We are designing an implant step which will implant phosphorus ions through 50 nm of S_iO_2 into an underlying silicon substrate such that the peak concentration in the substrate is $1x10^{17}$ cm^{-3} and the concentration at the S_iO_2 /Si interface is $1x10^{16}$ cm^{-3}. What energy and dose would you use to achieve these conditions? Assume that the stopping power of S_iO_2 is the same as that of silicon. Neglect channeling effects.

3C. (i). For dopant atoms uniformly distributed in a silicon crystal, how far apart are these dopant atoms when the doping concentration is a) 2 X 10^{15} cm^{-3}, b) 10^{18} cm^{-3}.

(ii). TCAD software is used for ………………………

(4+3+3)

4A. A diffused region is formed by an ultra-shallow implant followed by a drive-in. The final profile is Gaussian.

(i). Derive an expression for the junction depth (x_j) given a background dopant concentration (of the opposite type) of C_B.

(ii). Derive a simple expression for the sensitivity of x_j to the implant dose Q. Is x_j more sensitive to Q at high or low doses?

4B. A lightly doped Si wafer was processed by some unknown IC processing steps. Thermal oxidation is performed [fixed temperature and fixed oxidizing ambient] with this wafer and observed the following results:

Oxidation Time	SiO_2 Thickness
0 hour	0
1 hour	2000 Å
4 hours	2500 Å

Deduce the unknown IC processing steps experienced by the Si wafer. Are the following conjectures consistent with the observed oxidation results (TRUE or FALSE)? Give brief explanations to justify your answers.

Conjecture 1: The processed Si wafer was oxidized first to an oxide thickness of 100 Å and then have the oxide dissolved in HF.

Conjecture 2: The processed Si wafer has a thin layer of poly-Si layer on top surface.

4C. (i). If we perform an oxidation at a pressure of 20 atmosphere instead of at 1 atmosphere, will then be any change in oxide thickness? Indicate.

(ii). What is proximity effect? Explain.

(4+3+3)

5A. An X-ray exposure system uses photons with an energy of 1 keV. If the separation between the mask and wafer is 20 μm, estimate the diffraction limited resolution that is achievable by this system.

5B. Explain basic principle and mechanism involved in plasma etching. What are the reactions involved in this process? List.

5C. Explain LIGA process with neat diagram.

(4+3+3)