Ex/PG/ETCE/T/112E/16/2017

M. ETCE EXAMINATION, 2017
(1^{st} Semester)

MICROELECTRONIC TECHNOLOGY

Full Marks: 100 **Time: Three hours**

The figures in the margin indicate full marks.
Answer *any five* questions.
(All parts of the same question must be answered together at one place.)

1.a) Give brief description of different types of (i) Point defects and (ii) Line defects in a semiconductor that may appear during processing of an IC. 10

b) Compare performances of *Si* and *GaAs* as microelectronic material. 6

c) What are *Primary* and *Secondary flats*? Sketch (100) and (111) *n*-type *Si* wafers with appropriate markings. 2+2

2.a) Give schematic description of Czochralski method for growth of single crystal *Si*. 7

b) Define Effective segregation coefficient. Derive an expression for doping concentration in terms of the above coefficient as a function of the fraction of a doped solidified crystal. Also mention the conditions for uniform dopant distribution. 2+9+2

3.a) What are different roles played by an oxide layer in *Si* IC technology? 4

b) What are dry and wet oxidations? Which oxide is preferred in growing (i) Thin gate oxide and (ii) Thick field oxide? Mention the reasons. 2+2+2

c) $x^2 = Ax = B(t+\tau)$, all terms having their usual significances. Prove the compact description of growth of oxide on *Si*. 10

4.a) What is meant by a *Clean room* in microelectronics laboratory? What are its classifications? 2+4

b) Describe various ways in which dust particles can interfere with photomask patterns. 6

b) In a class 10 clean room, a 200 *mm* wafer is exposed for 1 *min.* to an air stream under a laminar-flow condition at 40 *m/min.* If there are 500 chips on the wafer, determine the percentage of affected chips. Assume that at most one dust particle may land on a single chip. 8

5.a) Derive Fick's diffusion equation in context of diffusion of impurities within a semiconductor. 4

b) Write the boundary conditions, and the solution of the diffusion equation in case of 5+6
i) Limited source diffusion, and
ii) Infinite source diffusion.
Mention general features of the above impurity distributions..

c) Describe a scheme for measuring the depth of a diffused junction. 5

6.a) Classify interconnects with a brief mention of their features. 6

b) Describe roles of insulating materials with both high and low permittivity in ULSI circuits. 8

c) A DRAM capacitor has the following parameters: 6
$C=30\ fF$, cell size (A) = 1.30 μm^2 and $k = 4$ for SiO_2 layer. Determine thickness of the SiO_2 layer. What will be equivalent area of the capacitor if SiO_2 be replaced with
(i) Si_3N_4 (k=7) and (ii) Ta_2O_5 (k=25) ?

7. a) Define *Reliability* and *Failure rate* of a system. Explain general nature of variation of the system failure rate with time of operation. 2+6

b) A equipment is composed of 3 identical components. Describe the situations when *product law of reliability* or *product law of unreliability* holds in estimating the overall reliability of the system. If reliability of individual component be 95%, what are the overall reliabilities of the equipment in above situations? 2+4

c) Describe the scheme of *Standby redundancy* and compare the reliability of the present arrangement with those in above cases. 6

8. Write notes on (*any two*): 2x10=20
(a) Optical exposure methods,
(b) Electron beam lithography,
(c) Ion implantation,
(d) Electro migration.