VLSI IC FABRICATION
(VLSI 5132)

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) Oxidation is used for
(a) isolation (b) interconnection (c) doping (d) packaging.

(ii) What kind of substrate is provided above the barrier to dopants?
(a) Insulating (b) Conducting (c) Silicon (d) Semiconducting.

(iii) Optical masking is used for
(a) pattern transfer (b) protection (c) cleaning (d) none of the above.

(iv) The damage in the ion-implanted sample is primarily due to
(a) electronic stopping
(b) nuclear stopping
(c) a combination of electronic and nuclear stopping
(d) none of the above.

(v) In semiconductor manufacturing, “lithography” is used
(a) To dope semiconductors
(b) To deposit amorphous films on semiconductors
(c) To deposit polycrystalline films on semiconductors
(d) To produce patterns in the films deposited on semiconductors.

(vi) Photoresist layer is formed using
(a) high sensitive polymer (b) light sensitive polymer
(c) polysilicon (d) silicon di oxide.

(vii) Interconnection pattern is made on
(a) polysilicon layer (b) silicon dioxide layer
(c) metal layer (d) diffusion layer.

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

(ix) Ion implantation is a technique to
(a) dope a semiconductor
(b) deposit an insulating layer on a semiconductor
(c) deposit a metallic layer on a semiconductor
(d) deposit a metallic layer on an insulator.

(x) What are the types of oxidation?
(a) Dry oxidation (b) Wet oxidation
(c) Both (a) & (b) (d) None of the above.

Group - B

2. (a) What is the meaning of "segregation coefficient"? Explain its effect on the Czochralski growth of Silicon. [(CO2)(Analyze/IOCQ)]
(b) Prove that the oxide growth rate is linear parabolic in thermal oxidation. [(CO2)(Create/HOCQ)]
(c) Write a short note on 'clean rooms'. [(CO1)(Remember/LOCQ)]
4 + 5 + 3 = 12

3. (a) Compare the size of bacteria and virus, that causes killing defects in the 16 K and 64 DRAM chips. [(CO1)(Analyze/IOCQ)]
(b) "Photolithography preferred to be done in a class-10 clean room and in yellow light": Justify the statement. [(CO3)(Evaluate/HOCQ)]
(c) "Larger the crystal, smaller the pull rate" – Explain. [(CO2)(Understand/LOCQ)]
4 + 4 + 4 = 12

Group - C

4. (a) Write and summarize the stopping mechanism in ion implantation. [(CO4)(Synthesis/IOCQ)]
(b) Explain that the Reynold number is important for epitaxial growth? [(CO2)(Evaluate/HOCQ)]
(c) Illustrate the physical cleaning process for Si-wafer. [(CO2)(Knowledge/LOCQ)]
4 + 4 + 4 = 12

5. (a) Calculate the percent of molecules that suffer collisions during travel from a source to the substrate in a deposition system at 0.5 Pa and 10^{-4} Pa. The source to substrate distance is 50 cm. Assume a typical molecular diameter of 3 angstrom. [(CO4)(Evaluate/HOCQ)]
(b) What are the advantages of thermal oxidation? What is transverse straggle? [(CO2)(Remember/LOCQ)]
6 + 6 = 12

Group - D

6. (a) Give two important reasons why lithography is one of the most critical technologies in semiconductor manufacturing? What are the basic steps in a lithography sequence? [(CO3)(Remember/LOCQ)]

(b) In optical lithography, which parameter fundamentally determines the minimum resolvable feature size? Explain your answer briefly. [(CO3)(Evaluate/HOCQ)]

(2 + 5) + 5 = 12

7. (a) Describe the Fick's 1st law and 2nd law of diffusion? Illustrate the influential parameters to control the diffusion rate of impurities into semiconductor lattice? [(CO4)(Remember/LOCQ)]

(b) Illustrate and outline the advantages of thermal oxidation? What is transverse straggle? [(CO4)(Analyze/IOCQ)]

(3 + 3) + (3 + 3) = 12

Group - E

8. (a) What is epitaxy? [(CO5)(Remember/LOCQ)]

(b) Why is epitaxial growth necessary during device fabrication? [(CO5)(Apply/IOCQ)]

(c) Discuss the sputtering technique of film deposition. [(CO5)(Analyze/IOCQ)]

3 + 3 + 6 = 12

9. (a) Explain in details the n-well fabrication process. What is self aligned gate? [(CO6)(Remember/LOCQ)]

(b) What do you mean by Thin Film? Give some example of Thin Film technology. [(CO5)(Understand/LOCQ)]

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

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	48.95	30.20	20.83

Course Outcome (CO):

After the completion of the course students will be able to

1. Students will learn clean room concepts
2. Students will learn individual fabrication steps
3. Students will learn Pattern Transfer to Si from Mask using Lithography
4. Student will learn semiconductor doping techniques
5. Student will learn planner MOSFET fabrication process
6. Student will learn SOI fabrication Technology

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question