UNIVERSITY OF SOUTHERN MAINE

Department of Engineering

ELE 464 – Microelectronic Fabrication **Elective**

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Schedule: Lecture: 2- 1hr and 15min. lectures/week (M&W 2:00 – 3:15, JMC-151, in Spring 2007)

Course Description (Catalog):

Principles of processes used in the fabrication of bipolar and MOS integrated circuits and components. Photolithography, crystal and epitaxial growth, oxidation, diffusion and ion implantation, chemical and physical film deposition and etching. Passive and active component and process design. Occasional laboratory periods may be substituted for equivalent class time.
Lecture 3 hours. Prerequisite: ELE 262. Credits: 3

Contribution to Professional Component: Engineering Science and Design

Textbook:

R.C. Jaeger, Introduction to Microelectronic Fabrication", 2nd ed, Addison-Wesley 2002 (required)
S.A. Campbell, The Science and Engineering of Microelectronic Fabrication, Oxford Press 2001 (reference)
J.D. Plummer, M.D. Deal, P.B. Griffin, Silicon VLSI Technology Prentice Hall 2000 (reference)

Topics:

1. Why Silicon? A materials perspective on circuit integration in microelectronics, A review of semiconductor physics and semiconductor material properties.
2. Principles of photolithography, planar technology, monolithic integration and IC design.
3. Crystal structure and orientation, defects and impurities in semiconductor crystals.
4. Silicon wafer preparation: Chemical purification of silicon, crystal growth and doping, Czochralsi technique, zone refining.
5. Thermal oxidation of silicon: Kinetics and modeling of oxide growth, LOCOS and planarization techniques
6. Physics of MOS capacitor and the evaluation of MOS oxide quality and interface properties
7. Dopant Diffusion Processes:
   The diffusion equation and its solutions, solid solubility, nonlinear effects,
   Diffusion systems, selective doping through oxide masking,
   Evaluation techniques for diffused layers, sheet resistance, Irvin curves, C-V techniques
   Sheet resistance and diffused resistor design
8. Selective Dopant Implantation,
   Ion implantation systems, ion penetration profiles, damage and annealing
   MOS threshold voltage and implanted resistor design
9. Film Deposition and Etching:
   Physical and chemical vapor deposition principles and systems,
   Epitaxial growth; metal, oxide and polysilicon deposition and etching processes
10. Overview of Bipolar and Poly Gate CMOS Processes and process simulation.

Course Objectives:

1. Students will gain an understanding of what is required for circuit integration and why Silicon is the material of choice for integrated circuit fabrication.
2. Students will understand the principles of photolithography and its use in batch processed high density

integration of circuits. Students will learn types and properties of photoresist materials, and how they are used to create individual components in silicon by patterning of layers and selective doping.

3. Students will learn crystal properties of silicon, defects and impurities and their effect on devices.
4. Students will learn purification and single crystal growth and dopant incorporation to silicon.
5. Students will understand principles of oxidation of silicon, and will learn to use growth equations and charts to calculate oxide thickness for wet and dry oxidation and use of LOCOS in process integration.
6. Students will understand principles of impurity diffusion and learn to use diffusion equations and charts to calculate doping profiles and to design diffused resistors. Students will also learn the systems used for diffusion and the measurement techniques for evaluating diffused layers.
7. Students will understand principles of ion implantation and learn to use ion implantation equations and data to calculate doping profiles and masking layers, and to design processes for implanted resistors. Students will also learn the systems used for ion implantation.
8. Students will learn principles of physical and chemical deposition and etching of films deposited on silicon, the systems used for these processes; specifically, metal, SiO2, Si3N4, polysilicon and epi.
9. Students will learn the flow and the steps of standard Bipolar and CMOS fabrication processes.
10. Students will use mathematical tools (Mathematica) to calculate outcomes of the processes covered.

Measurable Outcomes:

1. Students will know the standard process flows used for integrated circuit fabrication, both Bipolar and CMOS.
2. Students will know principles of photolithography, mask making and, photoresist types and processing.
3. Students will be able to calculate dopant distribution, sheet resistance and junction depth after a diffusion process and, design a process flow and mask patterns to create a diffused resistors.
4. Students will be able to calculate dopant distribution, sheet resistance and junction depth after an ion implantation process and, design a process flow and mask patterns to create an ion implanted resistor.
5. Students will have gained the experience of using mathematical tools to calculate outcomes of various silicon fabrication processes like diffusion, oxidation and ion implantation.

Relationship to Program Outcomes*: BP2, BP3, BP4, PSAD2, PM2

Assessment Methods:

1. Graded exams.
2. Graded assignments

Grading Policy:

Takehome examinations, homework assignments and project reports are required to be returned in electronic form and use of MathCad/Mathematica is expected in calculations. Homeworks are due the same day of the next week. Late homeworks receive zero credit. Only one assignment per term may be forgiven.

Grade Distribution:

Exams (Midterm + Final)	60% (= 30% + 30%)
Take Home Exam or Project	30%
Quizzes and homeworks	10%

Academic Support for Students with Disabilities: Students who may need assistance due to a disability are encouraged to contact the Office of Academic Support for Students with Disabilities, Luther Bonney 242, ph. 780-4076, TTY 780-4395.

* Detailed Program Outcomes may be obtained from the Department Office.