

REDESIGNING THE CHEMICAL ENGINEERING CURRICULUM FOR CHALLENGES IN THE 21ST CENTURY

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Abstract — *This paper details the newly established undergraduate curriculum in the Department of Chemical Engineering at UCLA. The goal of this curriculum is to establish a multidisciplinary educational program to provide chemical engineering students a systematic education in Semiconductor Manufacturing and Nanotechnology. The knowledge and skills are provided through a series of courses that emphasize on integrating transport phenomena, kinetics, and thermodynamics into various processes used in semiconductor manufacturing, such as chemical vapor deposition, plasma processing, and contamination control. Hands-on laboratory training is an integral and central component of the curriculum, with emphasis on chemical processing, device fabrication, teamwork, technical presentation, and technical writing. Students from different departments form teams to practice engineering principles using the state-of-the-art equipment and the laboratory course comprises of a comprehensive training in fabricating and testing complementary metal-oxide-semiconductor solid-state devices. An interactive course webpage for encouraging students' interactions and learning outside of classroom will also be discussed.*

Index Terms $\frac{3}{4}$ Chemical engineering, curriculum reform, and microelectronics.

SUMMARY

The curriculum for the Semiconductor Manufacturing Option is comprised of 47 courses, totaling 199 course units, and is similar to the core Chemical Engineering Option. The major differences from the core chemical engineering curriculum include:

- Reduce the advanced chemistry elective courses from three to two.
- Add the Science of Engineering Materials course to replace one chemistry elective course.
- Add the Physics of Materials course to replace the Introduction to Mechanics of Deformable Solids course.
- Add the Physical Principles of Semiconductor Devices course.
- Replace one undergraduate unit operation laboratory course with the newly established semiconductor manufacturing laboratory course.
- Require two elective courses in semiconductor manufacturing.

The course on Science of Engineering Materials introduces the students to various materials used in engineering design. The Physics of Materials course teaches the students the electronic, optical, and magnetic properties of solid materials, while the Physical Principles of Semiconductor Devices prepares the students on the fundamentals of semiconductor materials, p-n junctions, and semiconductor based electronic devices. These prerequisite courses prepare the students for the capstone laboratory course on Semiconductor Manufacturing.

The new Semiconductor Manufacturing Laboratory course is a six credit unit course that comprises of four hours of lectures and four laboratory hours each week to provide both knowledge and training in semiconductor manufacturing. The lectures are organized into modules and instructed in parallel with the laboratory work. In the first seven weeks of the quarter, the course focuses on theories and models for various chemical processes. In the last three weeks, the course focuses on electronic device characterization and design of experiments. It is worth noting that chemical engineering students form teams with electrical engineers and material scientists in the laboratory to carry out the entire process flow in making solid state devices, including capacitors, p-n junctions, and complementary metal-oxide-semiconductor (CMOS) transistors. This special team assignment simulates a real work environment in the microelectronics related industry, where engineers are required to apply the knowledge in various disciplines to engineer novel semiconductor manufacturing processes. In addition to these core courses, two elective courses in the semiconductor manufacturing area are required from over ten courses in Chemical Engineering, Electrical Engineering, and Material Science Departments.

Curriculum innovation and integration in semiconductor manufacturing and engineering is needed for training chemical engineering students for the 21st century. This new multidisciplinary curriculum is an ambitious program that aims at the education and training, in Semiconductor Manufacturing, of engineering students from a variety of disciplines. This is a technologically advanced area of manufacturing that faces significant labor shortages. Up to forty students can be trained each year through this program. Students who have successfully completed this option are highly sought after by industrial recruiters and academic graduate programs nationwide.

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