**EEE 435 Microelectronics (3) [S]**

**Course (Catalog) Description:**
Introduces basic CMOS and MEMS processing and fabrication tools. Covers the fundamentals of thermal oxidation, CVD, implantation, diffusion, and process integration.
On-campus lab. Fee. Course Type: Technical Elective.

**Pre- or co-requisite:**
EEE 436

**Textbook:**
Campbell, *The Science and Engineering of Microelectronic Fabrication*, 2nd Edition 2000 Oxford UP, 1990 ISBN: 0195136055.

**Supplemental Materials:**
All of the course material including lecture notes and laboratory materials are available on-line.

**Coordinator:**
T.J. Thornton, Professor

**Prerequisites by Topic:**
1. Crystalline nature of solids
2. Classical and quantum mechanical description of solids
3. Drift and diffusion carriers
4. Excess carriers in semiconductors
5. P-N junctions
6. Metal-semiconductor contacts
7. Schottky diodes
8. Bipolar transistors
9. Field-effect devices
10. Integrated circuits

**Course Objective:**
1. Students understand the practical and theoretical aspects of basic CMOS and MEMS processing.

**Course Outcome:**
1. Students understand the theoretical aspects of basic semiconductor processing and are exposed to the key practical steps in a clean-room laboratory environment.

**Course Topics:**
1. Introduction to CMOS processing
2. Wafer Cleaning
3. Defects in Semiconductors
4. Thermal oxidation
5. Chemical and Physical Vapor Deposition

6. Lithography
7. Etching
8. Diffusion
9. Ion implantation
10. CMOS Process Integration
11. MEMS Technology
12. Device measurement and parameter extraction

**Computer Usage:**
Students make use of an advanced process simulation tool called Athena. They use Athena for their laboratory work to simulate processes they actually perform in the cleanroom. Students also work with Athena for individual homework assignments. Students are also expected to use mathematical analysis software (e.g. Excel or MathCad) to analyze data they measure during the laboratory sessions.

**Laboratory Experiments:**
Students meet weekly for a three-hour laboratory under the guidance of a TA.
1. Wafer Cleaning
2. Thermal Oxidation
3. Photolithography
4. Reactive Ion Etching
5. Dopant Diffusion
6. MOSFET Characterization
7. MEMS Device Characterization

**Course Contribution to Engineering Science and Design:**
This course teaches Engineering Science through the application of advanced process modeling techniques to real world data measured during the laboratory sessions. For example, students adjust the process parameters in the Athena model to fit the measured data of oxide thickness grown at 1050° C for various times. Students are also exposed to Engineering Design problems by using the simulated and measured data to design MOS structures with certain characteristics. For example, they design a CMOS process flow to give a transistor with a threshold voltage of 0.7 V.

**Course Relationship to Program Outcomes:**
The course contributes to achieving the following program outcomes:
**b:** Significant laboratory component with experiment design and conduct. The laboratory sessions yield data that the students use to extract process simulation parameters.
**c:** Students acquire hands-on experience of relevance to contemporary CMOS processing.
**k:** Students use modern process simulation tolls for laboratory projects and individual homework assignments.

Person preparing this description and date of preparation: Trevor Thornton, March 2008, June 2015.