Syllabus
Semiconductor Process Control
ECE6455
Prof. Linda Milor

Recommended Texts:
G.S. May and C.J. Spanos, *Fundamentals of Semiconductor Manufacturing and Process Control,* Wiley, 2006.
D.C. Montgomery, *Introduction to Statistical Quality Control,* 8th Edition, Wiley, 2019.

Prerequisite:
Undergraduate coursework in statistics

Course Description:
A modern high volume IC manufacturing line requires equipment that is stable over time and process recipes that are optimized for equipment and product performance. For maximum yield, both the recipes and the IC designs must be desensitized to the manufacturing variations. This course focuses on the tools and methodologies to achieve these goals. The primary focus will be on statistical methods for analyzing processes (and circuits) given variability and techniques to build empirical models.

Outcomes:
1. Design of experiments to determine the "best" process recipe.
2. Design of control charts to detect loss of statistical control for a process.
3. Identify the appropriate empirical modeling methodology for a problem.
4. Build empirical models of complex processes, including nonlinear and high-dimensional functions using commercial toolsets.

Course Policies:
There will be a weekly assessment. Assessments will be either quizzes or assignments. A curve will be used to determine the final grade, based on the total points.

Late Submission:
If unexcused, late submissions are not accepted. Complete the quizzes well before the deadline so that any issues can be fixed before it's too late. Email me with excused delays to work out submission details in advance.

Grade Disputes:
Requests to regrade any quiz or assignment must be made within one week of the deadline. In the event of a regrade, the entire quiz or assignment may be regraded.

Topical Outline:
1. Semiconductor Manufacturing Overview:
   - Goals of manufacturing. Evolution of manufacturing.

- IC fabrication overview. IC unit processes (oxidation, lithography, diffusion, ion implantation, etching, metallization). Process integration. Metrology.

2. Review of Statistics:
   - Basic distributions. The central limit theorem. Sampling. Hypothesis testing. Comparing means and variances.
   - Yield analysis. Random yield. Systematic yield. Yield learning. Reliability analysis.
3. Design of Experiments:
   - Comparison of treatments. The assumption of independence. Blocking and randomization.
   - Measuring the effects of variables. Two-level factorials. Yate's algorithm.
   - Blocking and confounding. The design of fractional factorial experiments.
   - Taguchi methods for experimental design.
   - Least squares modeling and regression analysis. Response surface methods.
   - Principal components analysis.
   - Modeling with multivariate adaptive regression splines and other machine learning methods.
4. Control Charts:
   - The assignable cause. Statistical basis of the control chart. Control limits. Operating characteristic function.
   - Control charts for attributes. Fraction non-conforming. Control charts for variables. Average, range, and variance charts.
   - The concept of maximum likelihood and the CUSUM chart. Student's t-test and other control alternatives. Multivariate control. Time series modeling.

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