

**Reliability of Materials**  
**ENMA 489R**  
**Instructor: Aris Christou**  
**Syllabus**

**Course Objectives**

The main objective of the course is to understand the basic degradation mechanisms of materials, devices and components through the understanding of the physics, chemistry, mechanics of such mechanisms. Mechanical failures are introduced through understanding fatigue, creep and yielding in materials, and devices. Physical or chemical related failures are introduced through a basic understanding of physical mechanisms such as diffusion, electromigration, defects and defect migration, surface trapping mechanisms, charge creation and migration. Failure mechanisms observed in engineering materials will also be presented as well as failure mechanisms in semiconductor devices.

**Course Instructor:** Professor Aris Christou

**Office Hours:** Tuesday and Thursday 2:00-3:00 PM, CHE-NUC 2309

**Course Texts:** " Practical Reliability Engineering" by Patrick O'Conner, published by Wiley, Fourth Edition and "Failure Mechanisms in Semiconductor Devices", Second Edition by A. A. Amerasekera and F. N. Najm, published by Wiley.

*Reference:*

“Reliability and Quality in Microelectronic Die Manufacturing” by Aris Christou and Willie M. Webb,  
Published by Reliability Information Analysis Center, 2006.  
ISBN-10 1-933904-15-1 (reference).

**Course Notes and Assignments:** Posted on [www.blackboard.com](http://www.blackboard.com)

**Course Outline**

- Definitions, Dimensions, Objectives, Case Studies. The objectives of the course are presented. The overview of material failure mechanisms at the component level are discussed. The mathematics of reliability and quality as well as the design of experiments is reviewed (three weeks). Reading: O Conner, Chpts 1-3 and Amerasekera, Chpts 1,2.

- **Reliability and Product development:** Product effectiveness, failure mechanisms at the basic material and product development. The physics of failure approach to semiconductor device development is presented is also covered. Reliability Prediction and modeling and statistical approaches (two weeks). Reading: O' Conner, Chpts 5-7 and posted notes.
- **Analysis of Failure:** Mechanical and physical failure analysis techniques. We will emphasize microscopy techniques including acoustic microscopy (one week).
- **Material failures:** Defects in Materials, properties of materials, Mechanics of materials at the device level are presented. Load-Strength interference methods are discussed (one week). Reading: O'Conner, Chapt 4 and notes.
- **Failure Mechanisms:** Discussion of mainly mechanical failure mechanisms of metals, ceramics and semiconductors (one week). Reading: O'Conner, Chpt 8.
- **Failure Mechanisms:** Discussion of electrical failure mechanisms as related to dielectrics, hot carriers, ESD and latchup (two weeks). Reading: Amerasekera, Chpt 3 and O'Conner, Chpt 9.
- **Failure Mechanisms:** Discussion of physical failure mechanisms such as diffusion related metal migration, electromigration in interconnects, stress-induced voiding and breakdown events induced by biased-thermal stresses (two weeks). Reading Amerasakera, Chpts 4,5 and notes.

**Examinations:** Two exams ( 30 percent) and final examination (30 percent) will be given

**Projects:** One course project will be assigned which will include an in-class presentation (30 percent)

**Homework:** Six homeworks will be assigned and graded (10 percent).