ME/CEE-395 COMPUTATIONAL FORENSICS AND FAILURE ANALYSIS
Date/Time: Tues/Thurs 3:30-4:50 pm Room: TBA

Professor Mark Fleming

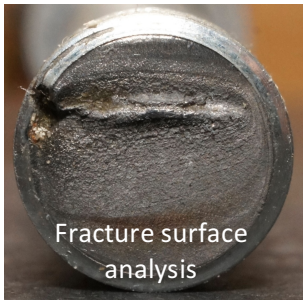
Prerequisites: ME/CEE 327 Introduction to FEM (or equivalent)

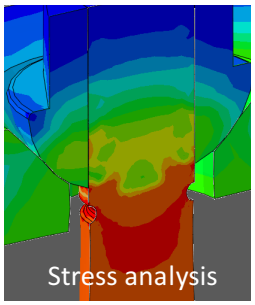
Course description

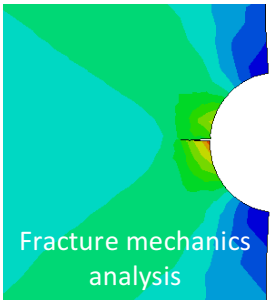
This course will provide insight and knowledge into the application of computer simulation methods for forensic and failure analysis problems. Students will learn how to:

- Use engineering analysis to **assess physical evidence**, such as deformed structures and fracture surfaces
- How to **use finite element analysis**, combined with the analysis of physical evidence and the application of fundamental engineering mechanics principles, as part of a **failure analysis**.
- Learn to present results decisively and effectively

This scope of this course will cover the use of the scientific method for accident investigation, hypothesis development, and the use of the finite element method to analyze the root cause of a failure. Practical application problems for both civil and mechanical structures will be analyzed using commercial finite element codes (Abaqus, Hypermesh, LS-Dyna).







Who should take this course?

Seniors and graduate students in the Mechanical Engineering, Civil and Environmental Engineering, and Material Science departments, along with students in the MSME Simulation-Driven Engineering (SDE) program.

Syllabus of Topics Covered

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1. **INTRODUCTION TO FORENSIC AND FAILURE ANALYSIS**
2. **FINITE ELEMENT METHOD AND FORENSIC ANALYSIS**
3. **PRODUCT DESIGN AND PRODUCT LIABILITY**
4. **COMPUTATIONAL METHODS FOR FATIGUE ANALYSIS**
5. **ACCIDENT INVESTIGATION, DATA GATHERING AND HYPOTHESIS DEVELOPMENT**
6. **NONLINEAR FEA FOR CRUSH AND DEFORMATION ANALYSIS**
7. **FRACTOGRAPHY AND MATERIAL EVALUATION**
8. **COMPUTATIONAL METHODS FOR FRACTURE ANALYSIS**
9. **FINITE ELEMENT ANALYSIS AND FORENSIC ANALYSIS**
10. **FAILURE MODES AND EFFECTS ANALYSIS (FMEA)**
11. **INTERFACING AND PROBLEM SOLVING WITH OTHER DISCIPLINES**
12. **ENGINEERING AND PROFESSIONAL ETHICS**

Grading: 20% Homework, 20% Midterm, 50% on two projects, 10% on classroom participation.

REFERENCE MATERIALS

1. Wulpi, D.J., *Understanding How Components Fail*, ASM 1985.
2. Jacob Fish and Ted Belytschko, *A First Course in Finite Elements,* 2007.
3. John Barsom and Stanley Rolfe, *Fatigue and Fracture Control in Structures, 1987.*
4. ASM Handbook Vol 19, Fatigue and Fracture.

Lecture notes, handouts, computer codes and references to book chapters and articles for additional reading will be provided.