PD268
Fracture Mechanics

Day One
- Introduction – Lecture, video, and discussion
  - Video: "The Last of the Liberties", which documents the brittle fracture of the Liberty Ships in WW II and the resulting birth of fracture mechanics as an engineering discipline.
  - Fracture mechanics versus strength-of-materials approach to design against fracture
  - Fracture mechanics versus S-N curve approach to design against fatigue failure

- Linear elastic fracture mechanics (LEFM) – Lecture, discussion, and examples
  - The Griffith model for cracks
  - The energy release rate parameter
  - The stress intensity factor (K)
  - Crack tip similitude
  - Crack tip plasticity
  - K_{Ic} testing

- Elastic-plastic fracture mechanics – Lecture, discussion, and examples
  - Crack tip opening displacement (CTOD) parameter
  - J-integral parameter
  - J_{Ic} and J resistance curve testing
  - Similitude under elastic-plastic conditions

Day Two
- Introduction to fatigue crack growth – Lecture, discussion, and examples
  - Similitude in fatigue
  - Empirical crack growth equations
  - Life prediction by numerical integration
  - Using crack growth analysis to define inspection intervals

- Advanced topics in fatigue – Lecture, discussion, and examples
  - Crack closure
  - Linear damage model for variable-amplitude loading
  - Retardation and load interaction
  - Growth of small cracks

- Environmental cracking – Lecture, discussion, and examples
  - Basic principles and terminology in corrosion engineering
  - Stress corrosion cracking (SCC)
  - Hydrogen embrittlement
  - Corrosion fatigue
  - Laboratory testing

- LEFM Applications – Lecture, discussion, and examples
  - The principle of superposition
  - Computing stress intensity factor for polynomial stress gradients
  - The weight function method for arbitrary stress gradients

Day Three
- Elastic-plastic applications – Lecture, discussion, and examples
  - The EPRI J estimation handbook
  - Ductile instability
  - The failure assessment diagram (FAD) method
  - Incorporating weld residual stresses into the FAD method
  - Monte Carlo probabilistic analysis

- Finite element analysis of components with cracks – Lecture, discussion, and examples
  - Incorporating a crack into a finite element mesh
  - Comparison of methods to compute KI
  - Modeling crack growth with finite element analysis

- Fracture mechanisms in metals & alloys – Lecture, discussion, and examples
  - Ductile fracture (microvoid coalescence)
  - Cleavage fracture
  - The ductile-brittle transition region
  - Intergranular fracture

- General discussion and course wrap-up