### Day | Hours | Introduction
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M 1/7 | 1.5 | Historical Perspective. Overview of main concepts. 1.1, 1.4*.
W 1/9 | 1.5 | Westergaard’s solution of crack in infinite plane. 4.2, 4.3
F 1/11 | 1.5 | Asymptotic near tip fields, modes I, II, III, stress intensity factors, fracture toughness.
M 1/14 | 1.5 | Rice’s $J$-integral for energy flux. Determination of LEFM parameters. 2.1.5-6, 4.4
W 1/16 | 1.5 | Size effects in fracture mechanics vs. plasticity, scaling of energy release. 1.2.5, 6.1, 6.2
F 1/18 | 1.5 | Fracture process zone and crack bridging zone in concrete, rocks, ceramics, etc.
W 1/23 | 1.5 | Models of Dugdale and Barenblatt. Cohesive (fictitious) crack model of Hillerborg. 5.2
F 1/25 | 1.5 | Softening stress-displacement relations, and relation to fracture energy. 8.3
W 1/30 | 1.5 | Resistance curve ($R$-curve). Crack equilibrium and energy analysis of fracture stability. $R$-curve determination as the envelope of fracture equilibrium curve for different sizes.
M 2/4 | 1.5 | Fracture analysis based on $R$-curves. Snapback instability at ligament tearing.
F 2/8 | 1.5 | Geometrically similar structures, power scaling laws. Size effect as a principal characteristic of quasibrittle fracture. Exper. evidence for concrete, rock, ice, composites.
M 2/11 | 1.5 | Energy derivation of size effect law for quasibrittle materials. Asymptotic analysis. 6.3
W 2/13 | 1.5 | Determining fracture energy and process zone length from size effect measurements. 6.4
M 2/18 | 1.5 | Calculation of $R$-curve from size effect data. Applications to various types of structures. Britteness and size effect in structural design. 6.2.3, 10.1, 10.2, 10.5

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### 2. Essentials of Linear Elastic Fracture Mechanics (LEFM)
- Energy release rate and fracture energy 2.1
- Westergaard’s solution of crack in infinite plane. 4.2, 4.3

### 3. Nonlinear Fracture Mechanics and Cohesive Crack Model
- Fracture process zone and crack bridging zone in concrete, rocks, ceramics, etc.
- Models of Dugdale and Barenblatt. Cohesive (fictitious) crack model of Hillerborg.
- Compliance formulation of cohesive crack model. 7.1, 7.2, 7.4.2, 7.4.7
- Softening stress-displacement relations, and relation to fracture energy. 8.3

### 4. Equivalent LEFM, $R$-Curves and Fracture Stability
- Resistance curve ($R$-curve). Crack equilibrium and energy analysis of fracture stability.
- $R$-curve determination as the envelope of fracture equilibrium curve for different sizes.

### 5. Scaling and Size Effect
- Geometrically similar structures, power scaling laws. Size effect as a principal characteristic of quasibrittle fracture.
- Energy derivation of size effect law for quasibrittle materials. Asymptotic analysis. 6.3
- Determining fracture energy and process zone length from size effect measurements. 6.4
- Calculation of $R$-curve from size effect data. Applications to various types of structures. Britteness and size effect in structural design. 6.2.3, 10.1, 10.2, 10.5
- Size effect in cohesive crack models for concrete, rocks, composites, ice, wood. Slopes.

### 6. Statistical Fracture Mechanics
- Statistical Strength Theory and Size Effect. 12.1, 12.2, 12.3

### 7. Effects of Time, Rate, Creep, Temperatures, Load Cycling and Distributed Damage
- Rate and thermal effects in fracture. Effect of creep, and influence on size effect. 11.2
- Generalization of cohesive crack model. 11.6 Parallel crack spacing.
- Fatigue crack growth in quasibrittle materials, Paris law and its size dependence. 11.7

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**PREREQUISITES:** Solid background in mathematics and mechanics at the undergraduate level, including calculus, differential equations, mechanics, mechanics of materials, elements of continuum mechanics and theory of structures.

**Recommended Texts:**

*These numbers denote related chapters or sections in Bažant and Planas’ book. However, coverage has been condensed and updated.*