Topics covered so far (it will be updated weekly)

- Introduction to fracture mechanics
  - Unexplained failures
  - length scale effects
- Complex variable method
  - Analytic function
  - Cauchy-Riemann conditions
  - Complex formulation of plane elasticity problems
- Displacement and stress formulations for plane stress and strain cases
- Detailed derivation of KM approach
- Different forms of stress function
- Energy-based analysis
  - Griffith's approach of energy balance
  - Griffith's failure criteria
  - Computation of strain energy for different loadings
  - Strain energy release rate for constant load and displacement cases
  - Fracture strength by Griffith
  - Necessary and sufficient conditions for fracture (critical crack) in brittle and ductile materials
  - Estimation of theoretical cohesive strength
  - Energy release rate in terms of potential energy and compliance of material
  - Graphical representation of fracture for brittle materials (plane stress and plane strain)
  - Resistance curve for ductile materials in plane stress case
  - Pop-in phenomenon for intermediate thickness specimen
- Stress-based analysis
  - Airy stress function for mode-I fracture (Westergaard stress function)
  - Westergaard solution of mode-I fracture stress field (plane stress and plane strain)
  - Consequence of Westergaard solution and Irwin's correction
  - Derivation of displacement field based on mode-I fracture Westergaard stress field (plane stress and plane strain)
  - Relation between strain energy release rate (G) and stress intensity factor (SIF) for mode-I case
  - Generalized derivation of relation between G and SIF for mode-I case
  - Westergaard stress and displacement fields for mode-II and mode-III cases (with crack center and crack tip as origin)
  - Generalized Westergaard approach based on two complex functions
  - Evaluation of SIF for various loadings for mode-I fracture, and mixed mode cases
  - SIF of edge cracks, principle of superposition in the evaluation of SIF
  - SIF of embedded penny shaped cracks (circular and elliptical flaws)
  - SIF of surface flaws (semi-elliptical and one-quarter elliptical shallow cracks)
  - Fracture toughness comparison for edge and surface cracks

- Modelling of inelastic deformation
  - Selection of fracture toughness for different types of cracks
  - Small scale yielding
  - Computation of plastic zone, using von Mises and Tresca criteria, ahead of crack tip for through-the-thickness central crack under far field loading (plane stress and plane strain cases)
  - Computation of plastic zone for mode – I and mode – III cases by Westergaard's stress field with crack tip as origin
  - Computation of effective crack length by Irwin and Dugdale models

- *J*-integral
  - Proof of $J = G$
  - $J = 0$ for a closed path (J is path independent)
  - Applicability of J integral
  - Compute J for Dugdale model

- CTOD
  - Derivation of CTOD for Irwin and Dugdale models
  - Equivalence between G and J
  - J_{SSY} for Dugdale model
  - COD design curves

- Cohesive zone modelling