Course Type	Course Code	Name of Course	L	T	P	Credit
DE	NMED523	Computational Fracture Mechanics	3	0	0	3

Course Objective

The primary objective of the course is to expose the students to:

- Use of Finite Element Analyses for computing different fracture growth quantification parameters (SERR, SIF, CTOD, J-Integral) based on classical fracture mechanics
- Use of Special Finite Elements used for fracture analyses.
- Use Finite Element Analyses for modeling and simulation of fracture in different types of engineering materials (LEFM/EPFM)
- Use of basic fracture growth criteria to predict the onset of existing fractures in engineering structures using Finite Element Formulations.
- Use of FEM based commercial codes (ANSYS APDL) for fracture growth analyses in practical Engineering structures.

Learning Outcomes

On successful completion of this course, students will be able to:

- Compute the fracture growth quantification parameters (SERR, SIF, CTOD, J-Integral) suggested through classical fracture mechanics.
- Select specific elements to be adopted in finite element analyses based upon the intended fracture parameter to be used for crack growth analyses.
- Model and simulate the fracture growth in engineering structures of different material characteristics (LEFM/EPFM)
- Predict the criticality of existing fractures under specified loading and boundary conditions through the use of standard fracture growth criteria evaluated through Finite Element Formulations.
- Analyze fracture growth in practical engineering structures using FEM based commercial codes (ANSYS APDL).

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	**Introduction to Fracture Mechanics and FEM.** Introduction, Classification of Fracture processes, Model Assumptions, Linear Elastic Fracture Mechanics, Elastic-plastic Fracture Mechanics, and Fatigue crack Propagation, Dynamic Fracture process, Basic equations of FEM, Numerical realization of FEM, FEM for non-linear boundary value problems, Explicit FEA for Dynamic Problems.	9	The students will get introduced to the basics of Fracture Mechanics and Finite Element analyses based formulations.
2	**Finite Element Techniques for crack analyses in Linear Elastic Structures:** Special Elements at the crack tip, Hybrid crack tip elements, Method of Global Energy Release Rate, Virtual Crack Extension Approach, Method of Crack Closure Integral, FE computation of J-contour Integrals, Fracture Mechanics	8	Students will get introduced to the Finite Element Techniques to analyze Linier elastic structures along with cracks.

	Weight Functions, Case study: Analyses of Tension sheet with internal crack, Semi-elliptical Surface crack under tension		
3	**Finite Element Techniques for crack analyses in Elastic Plastic Structures:** Elastic Plastic crack tip elements, Determination of Crack Tip Opening Displacements, Calculation of J-integral, Case studies: Compact Tension Specimen, Tensile plate with Surface cracks.	8	Students will get introduced to the Finite Element Techniques to analyze Elastic Plastic structures along with cracks.
4	**Numerical Simulation of Crack Propagation:** Introduction to different fracture growth criteria: Critical ERR criteria, Linear fracture criteria, Bilinear Fracture criteria, B-K Fracture criteria, Modified B-K Fracture criteria, Power Law Fracture Criteria, User defined fracture criteria, Nodal Release technique, Moving crack tip elements, Adaptive re-meshing strategies, VCCT based node by node crack growth, Cohesive Zone Model (CZM), Damage Mechanical Model, Case studies: Fatigue crack propagation, Ductile crack propagation	9	Students will be introduced to Finite Element Analyses based simulation of fracture growth (crack propagation)
5	**Case studies on Fracture growth analyses in Engineering Structures through ANSYS:** Fatigue crack growth analyses in Railway wheel, Brittle fracture assessment of a container under impact loading, Ductile fracture of a weldment in a gas pipeline.	8	Students will learn analyzing fracture growth analyses in different practical Engineering structures using ANSYS
	Total	42	

Text Books /References:

1. Finite Elements in Fracture Mechanics: Theory-Numeric-Applications; Meinhard Kuna, Springer Publications

Reference Books:

1. The Finite Element Method for Mechanics of Solids with ANSYS Applications: Ellis H Dill, CRC Press Publications