ENGINEERING FRACTURE MECHANICS

PROF. K. RAMESH
Department of Applied Mechanics
IIT Madras

INTENDED AUDIENCES : Students in Engineering Colleges and working professionals in similar areas

PRE-REQUISITES : Basic course on Strength of Materials. Course on Theory of Elasticity desirable

INDUSTRIES APPLICABLE TO : HAL, Honeywell, GE, GM, NAL, DMRL, DRDO, BEML, Mahindra&Mahindra, Tata Motors, L&T, VSSC, Defense and Atomic energy Laboratories

COURSE OUTLINE :

The course covers the basic aspects of Engineering Fracture Mechanics. Spectacular failures that triggered the birth of fracture mechanics, Modes of loading, Classification as LEFM and EPFM, Crack growth and fracture mechanisms, Energy release rate, Resistance, Griffith Theory of fracture, Extension of Griffith Theory by Irwin and Orowan, R-Curve, Pop-in phenomena, Crack branching. Necessary and sufficient conditions for fracture, Stress and Displacement fields in the very near and near-tip fields, Westergaard, Williams and Generalised Westergaard solutions, Influence of the T-stress and higher order terms, Role of photoelasticity on the development of stress field equations in fracture mechanics, Equivalence between SIF and G, Various methods for evaluating Stress Intensity Factors, Modeling plastic zone at the crack-tip, Irwin and Dugdale models, Fracture toughness testing,Fedderson TMs residual strength diagram, Paris law, J-integral, HRR field, Mixed-mode fracture, Crack arrest methodologies.

ABOUT INSTRUCTOR :

Prof. K. Ramesh is currently the K Mahesh Chair Professor at the Department of Applied Mechanics, IIT Madras; and formerly a Professor at the Department of Mechanical Engineering, IIT Kanpur. He has made significant contributions to the advancement of Digital Photoelasticity. He received his undergraduate degree in Mechanical Engineering from the Regional Engineering College, Trichy (now NIT, Trichy), Postgraduate degree from the Indian Institute of Science, Bangalore and the Doctoral Degree from the Indian Institute of Technology Madras. He has made significant contributions to the advancement of Digital Photoelasticity. This has resulted in a Monograph on Digital Photoelasticity Advanced Techniques and Applications (2000), Springer, a chapter on Photoelasticity in the Springer Handbook of Experimental Solid Mechanics (2009), a chapter on Digital Photoelasticity in the book on Digital Optical Measurement Techniques and Applications (2015), Artech House London and a recently published book on Developments in Photoelasticity - A renaissance (2021), IOP Publishing, UK. He has over 190 publications to date of which two have been reproduced in the Milestone Series of SPIE. His research has been funded by organizations such as ARDB, ISRO, DST, EU (FP7) and NSF. He received the Zandman award for the year 2012, the first Indian to receive it since its inception in 1989, instituted by the Society for Experimental Mechanics, USA for his outstanding research contributions in applications utilizing photoelastic coatings. He has been a Fellow of the Indian National Academy of Engineering since 2006. He received several awards such as Distinguished Alumnus Award of NIT, Trichy (2008), President of India Cash Prize (1984). He has been a member of the Editorial Boards of the International Journals: Strain (since 2001), Journal of Strain Analysis for Engineering Design (2009–10), Optics and Lasers in Engineering, and a steering committee member of Asian Society for Experimental Mechanics since its inception in 2000.

COURSE PLAN :

Week 1 : EFM Course outline and Spectacular Failures
Week 2 : Introduction to LEFM and EPFM, Fatigue Crack Growth Model
Week 3 : Crack Growth and Fracture Mechanisms, Griffith TMs Theory of Fracture
Week 4 : Energy Release Rate
Week 5 : Review of Theory of Elasticity
Week 6 : Westergaard Solution for Stress and Displacements for Mode I, Relationship between K and G
Week 7 : Introduction to multi parameter stress field for Mode I, Mode II and Mixed Modes
Week 8 : SIF for Various Geometries
Week 9 : Modeling Plastic Deformation, Irwin TMs model, Dugdale Model
Week 10 : Fracture Toughness Testing, Paris Law and Sigmoidal curve
Week 11 : Crack Closure, Crack Growth Models, J-Integral
Week 12 : Failure Assessment Diagram, Mixed Mode Fracture, Crack Arrest and Repair Methodologies