Hydraulic Fractures: Multiscale phenomena, asymptotic and numerical solutions

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2:00-3:00 pm
Monday, January 25th
4-178 EECS Bldg.

ABSTRACT: Hydraulic fractures (HF) are a class of tensile fractures that propagate in brittle materials by the injection of a pressurized viscous fluid. In this talk I introduce models of HF and provide examples of natural HF and situations in which HF are used in industrial problems. Natural examples of HF include the formation of dykes by the intrusion of pressurized magma from deep chambers. Engineering applications include: the deliberate formation of fracture surfaces in granite quarries; waste disposal; remediation of contaminated soils; cave inducement in mining; and fracturing of hydrocarbon bearing rocks in order to enhance production of oil and gas wells. I describe the governing equations in 1-2D as well as 2-3D models of HF, which involve a coupled system of degenerate nonlinear integro-partial differential equations as well as a free boundary. I demonstrate, via re-scaling the 1-2D model, how the active physical processes manifest themselves in the HF model and show how a balance between the dominant physical processes leads to special solutions. I discuss the challenges for the numerical modeling of planar hydraulic fractures and the development of robust and efficient techniques to resolve this class of problems. I will also discuss some recent results on the combination of the Extended Kalman Filter with a numerical scheme in order to use remote measurements of the deformations induced by an HF to monitor its evolving geometry.

BIOGRAPHY: Anthony Peirce is a Professor in the Department of Mathematics at the University of British Columbia, Canada. He was a Fulbright Scholar at Princeton University, where he received his PhD in Applied and Computational Mathematics in 1987. Prior to his PhD, he worked as an Applied Mathematician at the Chamber of Mines Research Laboratories in South Africa, where he investigated rock fracture processes around underground excavations. His research interests include: the application of control to molecular systems, the analysis of instabilities in elasto-plastic materials, the development of specialized numerical algorithms to model large-scale rock fracture processes, numerical and analytic studies of reactive flows in porous media, and more recently, the asymptotic and numerical analysis of fluid-driven-fracture propagation. Further details are available on his website: www.math.ubc.ca/~peirce

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