ACCURACY OF FRACTIONAL STEP METHODS FOR DIFFERENTIAL ALGEBRAIC EQUATIONS (DAEs) ARISING FROM COUPLED PROBLEMS

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This presentation examines the accuracy of the method of fractional steps in time (or operator splitting) applied to DAEs arising from coupled problems. The class of coupled problems considered here are restricted to those involving coupling between mechanical deformations and an auxiliary evolving field such as temperature or pore pressure. Spatial discretization of the coupled field equations corresponding to the quasi-static case (where inertial effects are neglected) naturally leads to DAEs. This is in contrast to the dynamic case where inertial effects are included and a system of Ordinary Differential Equations (ODEs) result from spatial discretization. A naïve application of the well established splitting techniques developed in the ODE case to the DAE case may not perform well due to reduction in order of accuracy. In this talk, we demonstrate that: (1) first and second order splitting schemes developed for the ODEs when applied to the DAEs are only first order accurate; (2) recasting the DAEs in an alternate form can be used to preserve the original orders of accuracy. Knowing the orders of accuracy, adaptive time stepping strategies to control splitting error in the context of DAEs arising from a highly coupled nonlinear diffusion-deformation problem will be examined. Numerical results to verify the claims on orders of accuracy will be provided.