INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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The objective of this thesis is to provide higher order convergence of weak Galerkin finite element solutions to the exact solutions of some time dependent partial differential equations with Lipschitz continuous interfaces. In this thesis, we have proposed non-conforming fitted weak Galerkin finite element methods (WG-FEMs) for some interface problems with nonhomogeneous jump conditions and related convergence analysis are carried out under low global regularity of the true solution.

First, we analyze WG-FEMs for parabolic interface problems. Both continuous time Galerkin method and discrete time Galerkin methods are discussed. Fully discrete schemes are based on backward Euler and Crank-Nicolson time discretizations. Optimal order error estimates in L^2 and H^2 norms are established for both semidiscrete and fully discrete schemes. We next proceed to the a priori error analysis of wave equation with interfaces. Although various higher order finite element methods for elliptic and parabolic interface problems have been proposed and studied in the literature, but higher order finite element treatment of similar hyperbolic problems is mostly missing. In this work, we are able to prove optimal order point-wise-in-time error estimates in L^2 and H^1 norms for the wave equation with interfaces. Finally, we analyze WG-FEMs applied to pulsed electric model arising in biological tissue when a biological cell is exposed to an electric field. A fitted finite element method is proposed to approximate the voltage of the pulsed electric model across the physical media. Optimal pointwise-in-time error estimates in L^2-norm and H^1-norm are shown to hold for semidiscrete scheme even if the regularity of the solution is low on the whole domain. Further, a fully discrete finite element approximation based on backward Euler scheme is analyzed and related optimal error estimates are derived.