



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI  
SHORT ABSTRACT OF THESIS

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The main objective of this thesis is to develop high-order numerical schemes for the various simplified models that approximate Maxwell's equations involving the curl and divergence operators. In these problems, one has to deal with vector-valued function spaces  $H(\text{div})$  and  $H(\text{curl})$ , which offers many consequences for the numerical techniques as a whole. The collection of the existing literature has suggested that finite element methods (FEMs) are one of the most accurate, efficient, and reliable approximation schemes in scientific computing due to their significant applications for real world physical phenomena. Besides these advantages, the limited choices for the approximating spaces, underlying finite element partitions, low global regularity of the exact solutions, and interfaces having geometric singularities compromise the consistency of classical FEMs. So, there is still a scope to design cost-efficient higher order methods for  $H(\text{div})$  and  $H(\text{curl})$  problems for the general polygonal/polyhedral meshes. In an implementation, the finite partition which allows arbitrary shape elements provides additional flexibility in numerical methods and mesh generations such as general hybrid meshes, polygonal/polyhedral meshes, and meshes with hanging nodes. In recent years, newly developed weak Galerkin finite element methods (WG-FEMs) and least-squares weak Galerkin finite element methods (LSWG-FEMs) are much more appreciated in computational fields to solve different kinds of partial differential equations (PDEs). In this thesis, high-order accurate weak Galerkin finite element schemes to the PDEs having curl and divergence operators on the general polygonal/polyhedral domains have been designed and further, the convergence analysis is also extended for grad-div and curl curl-grad div interface problems with non-homogenous jump conditions. An additional attempt has been made to improve the order of convergence for the WG-FEMs. For this purpose, the least-squares weak Galerkin finite element approximations have been performed on a system of equations. The theoretical analysis of high-order convergence for the system of equations with polygonal/polyhedral meshes and meshes with hanging nodes adds more challenges than one could imagine.