

# Abstract

This dissertation is about  $G$ -algebra theory and incidence algebras and composed of four parts.

The first part depends on study of the algebra over a field and  $G$ -algebra over a field means a finite group acts on certain algebra. This concept is due to A. J. Green. We learn about the concept of an interior  $G$ -algebra, introduced by L. Puig and Broué and developed by Külshammer.

The second part is devoted to deal with particular algebra, namely incidence algebra over a field. We study some fundamental properties of an incidence algebra. We then construct a modular incidence algebra. We study the action of a finite group  $G$  on a modular incidence algebra.

The third part is based on a joint work with Ahmed Alghamdi. The content of this part is based on a prepublication in which we try to understand in the case of uncountable locally partial order sets. We study tensor product of two incidence algebras. We show that the tensor product of two incidence algebras is an incidence algebra.

The fourth part depends on study of the decomposition of the modular incidence algebra into a block algebra. We study defect groups of incidence algebra, pointed groups and nilpotent blocks. We present some examples of nilpotent blocks.

**Keywords:** Partially ordered set, Incidence algebras, Incidence functions, Modular incidence algebras,  $G$ -poset, Incidence  $G$ -algebras, Tensor product, Block incidence algebras, Nilpotent blocks.