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Structure and Representations for the Electrical Lie Algebra of Type D_4

We prove the dimension conjecture for electrical Lie algebra \mathfrak{e}_{D_4} of type D_4 . Moreover, we present a new method to construct 3-step nilpotent Lie algebras and show that \mathfrak{e}_{D_4} is isomorphic to the semidirect product of \mathfrak{sl}_2 with a 3-step nilpotent Lie algebra constructed from the colored complete bipartible graph $K_{2,2}$. Also, we classify all simple highest weight modules for \mathfrak{e}_{D_4} .

Keywords: Electrical Lie algebras, 3-step nilpotent Lie algebra, highest weight modules, simple modules.

MSC: 17B10, 17B20, 17B65, 17B66, 17B68.