

Commutativity conditions of some second order time-varying linear differential systems

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Abstract: The realization of many engineering systems consists of cascade connection of systems of simple orders, which is very important in design of electrical and electronic systems. Although the order of connection of the systems mainly depends on the special design approach engineering genuity, traditional synthetic methods, when the sensitivity, stability, linearity, noise disturbance, robustness effects are considered the change of the order of connection without changing the main function of the total systems (commutativity) may lead positive results. Therefore the commutativity is very important from the practical point of view.

The subject has appeared to be a tutorial paper in the literature; in spite of including the general commutativity conditions, this paper is lack of focusing on the special engineering problems from the commutativity point of view.

The aim of this presentation is to investigate the commutativity properties and its results for the well-known second-order time-varying differential equations each of which describes some particular physical systems, which will constitutes of the original value of the project. The expected outcomes will lead new design trends in engineering as to improve the total system performance covering sensitivity, stability, disturbance and even robustness.

In particular, the commutativity of systems described by Lommel, Halm and Legurre type differential equations are investigated and requirements for commutativity are derived. It is shown that under certain circumstances these systems have commutative pairs some of which have explicit analytical solutions.

Keywords: commutativity, time-varying systems, differential equations, initial conditions, stability, sensitivity, disturbance, robustness

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