Complementarity systems: an introduction

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Resumen

In this talk we study some characteristics of the dynamical behavior of switched power converters in the framework of linear complementarity systems (LCS). LCS are obtained as follows. Take a standard linear system, select a number of input/output pairs (u_i, y_i) and impose for each of these pairs that at each time t both $u_i(t)$ and $y_i(t)$ must be nonnegative, and at least one of them should be zero (positiveness + orthogonality). These are called the "complementarity conditions" (CC) and the pairs (u_i, y_i) are called "complementarity variables". These CC are well-known in mathematical programming, although not usually in combination with differential equations. In the context of electrical circuits, imposing complementarity conditions simply means that some ports are terminated by ideal diodes, with the current i_D and (minus) the voltage $-v_D$ as complementarity variables. Associated to each complementarity pair (u_i, y_i) there are two general situations allowed by the CC: either $u_i = 0$ and $y_i > 0$ or $u_i > 0$ and $y_i = 0$. In electrical engineering terminology, diodes may be blocking or conducting. If there are p diodes, one has $2p$ of these binary choices and the system can be in any of $2p$ so-called "modes". For power converters one has, in addition to (ideal) diodes, some (ideal) switches which are arbitrarily closed or open by a control law. Ideal switches do not dissipate or store power, and hence the product of current and voltage for any of them is zero, $i_S v_S = 0$. This resembles part of a CC; however one does not have, in general, a positiveness condition in this case (although some physical realizations of the switch may impose some kind of partial positiveness). The talk is devoted to an introduction to the theory of Complementarity Dynamical Systems. Basic results will be reviewed and applied to examples coming from electrical engineering.

(In collaboration with C. Batlle.)