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Bifurcation of limit cycles from an n-dimensional linear center inside a class of piecewise linear differential systems

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ABSTRACT

Let n be an even integer. We study the bifurcation of limit cycles from the periodic orbits of the n-dimensional linear center given by the differential system

$$\dot{x}_1 = -x_2, \qquad \dot{x}_2 = x_1, \quad \dots, \ \dot{x}_{n-1} = -x_n, \qquad \dot{x}_n = x_{n-1},$$

perturbed inside a class of piecewise linear differential systems. Our main result shows that at most $(4n-6)^{n/2-1}$ limit cycles can bifurcate up to first-order expansion of the displacement function with respect to a small parameter. For proving this result we use the averaging theory in a form where the differentiability of the system is not needed.

1. Introduction and statement of the main result

Piecewise linear differential systems appear in a natural way in the control theory, and in the study of electrical circuits. These systems can present complicated dynamical phenomena such as those exhibited by general nonlinear differential systems. One of the main ingredients in the qualitative description of the dynamical behavior of a differential system is the number and the distribution of its limit cycles.

The goal of this paper is to study, in $\mathbb{R}^n$ for all n even, the existence of limit cycles of the control systems of the form

$$\dot{x} = A_0 x + \varepsilon F(x), \tag{1}$$

with $|\varepsilon| \neq 0$ a sufficiently small real parameter, where A_0 is equal to

$$A_0 = \begin{pmatrix} 0 & -1 & 0 & 0 & \cdots & 0 & 0 \\ 1 & 0 & 0 & 0 & \cdots & 0 & 0 \\ 0 & 0 & 0 & -1 & \cdots & 0 & 0 \\ 0 & 0 & 1 & 0 & \cdots & 0 & 0 \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & 0 & 0 & \cdots & 0 & -1 \\ 0 & 0 & 0 & 0 & \cdots & 1 & 0 \end{pmatrix}$$

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