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Zero-Hopf bifurcation in a Chua system

Rodrigo D. Euzébio[a,b,*], Jaume Llibre[b]

[a] *Departament de Matemática, IBILCE, UNESP, Rua Cristovao Colombo 2265, Jardim Nazareth, CEP 15.054-00, Sao José de Rio Preto, SP, Brazil*

[b] *Departament de Matemàtiques, Universitat Autònoma de Barcelona, 08193 Bellaterra, Barcelona, Catalonia, Spain*

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ABSTRACT

A zero-Hopf equilibrium is an isolated equilibrium point whose eigenvalues are $\pm\omega i \neq 0$ and 0. In general for a such equilibrium there is no theory for knowing when it bifurcates some small-amplitude limit cycles moving the parameters of the system. Here we study the zero-Hopf bifurcation using the averaging theory. We apply this theory to a Chua system depending on 6 parameters, but the way followed for studying the zero-Hopf bifurcation can be applied to any other differential system in dimension 3 or higher.

In this paper first we show that there are three 4-parameter families of Chua systems exhibiting a zero-Hopf equilibrium. After, by using the averaging theory, we provide sufficient conditions for the bifurcation of limit cycles from these families of zero-Hopf equilibria. From one family we can prove that 1 limit cycle bifurcates, and from the other two families we can prove that 1, 2 or 3 limit cycles bifurcate simultaneously.

1. Introduction and statement of the main results

The Chua system is a classical model for electronic circuit and one of the most simplest models presenting chaos. It was presented by Chua, Komuro and Matsumoto [1] in 1986 and exhibits a rich range of dynamical behavior. There are several different models of Chua's systems see for instance [2–6].

The Chua circuit considered in [1] is a relaxation oscillator with a cubic nonlinear characteristic. It can be thought as a circuit comprising a harmonic oscillator for which the operation is based on a field-effect transistor, coupled to a relaxation oscillator composed of a tunnel diode. The Chua system can be described

* Corresponding author at: Departament de Matemática, IBILCE, UNESP, RuaCristovao Colombo 2265, Jardim Nazareth, CEP 15.054-00, Sao José de Rio Preto, SP, Brazil.
E-mail addresses: euzebio@ime.unicamp.br, rodrigo.euzebio@sjrp.unesp.br (R.D. Euzébio), jllibre@mat.uab.cat (J. Llibre).

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