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The general Liénard polynomial system: bifurcations and applications

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We consider Liénard equations

$$\ddot{x} + f(x)\,\dot{x} + g(x) = 0 \tag{1}$$

and the corresponding dynamical systems in the form

$$\dot{x} = y, \quad \dot{y} = -g(x) - f(x)y. \tag{2}$$

There are many examples in the natural sciences and technology in which this and related systems are applied. Such systems are often used to model either mechanical or electrical, or biomedical systems, and in the literature, many systems are transformed into Liénard type to aid in the investigations [1–4].

Suppose that system (2), where $f(x)$ and $g(x)$ are arbitrary polynomials of x, has an anti-saddle (a node or a focus, or a center) at the origin and write it in the form

$$\dot{x} = y, \quad \dot{y} = -x\,(1+a_1\,x+\ldots+a_{2l}\,x^{2l})+y\,(\alpha_0+\alpha_1\,x+\ldots+\alpha_{2k}\,x^{2k}). \tag{3}$$

Generalizing our results on Liénard polynomial systems [2, 3] and applying canonical systems with field rotation parameters [1], we study limit cycle bifurcations of (3) and prove the following theorem [4].

1 *The general Liénard polynomial system* (3) *has at most* $k+l+1$ *limit cycles,* $k+1$ *surrounding the origin and* l *surrounding one by one the other singularities of* (3).

[1] V. A. Gaiko, *Global Bifurcation Theory and Hilbert's Sixteenth Problem*, Kluwer, Boston, 2003.

[2] V. A. Gaiko, *Differ. Equ. Dyn. Syst.*, (2012), **20**, pp. 329–337.

[3] V. A. Gaiko, *Appl. Math. Letters*, (2012), **25**, pp. 2327–2331.

[4] V. A. Gaiko, *Adv. Dyn. Syst. Appl.*, (2015), **10**, pp. 177–188.