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New Family of Centers of Planar Polynomial Differential Systems of Arbitrary Even Degree

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Abstract
The problem of distinguishing between a focus and a center is one of the classical problems in the qualitative theory of planar differential systems. In this paper, we provide a new family of centers of polynomial differential systems of arbitrary even degree. Moreover, we classify the global phase portraits in the Poincaré disc of the centers of this family having degree 2, 4, and 6.

Keywords Poincaré compactification · Center · First integral · Invariant algebraic curve

Mathematics Subject Classification (2010) Primary 34A05; Secondary 34C05 · 37C10

1 Introduction and Statement of the Main Results

Let $P(x, y)$ and $Q(x, y)$ be two real polynomials. In this work, we deal with *polynomial differential systems* in $\mathbb{R}^2$ of the form

$$\dot{x} = P(x, y), \quad \dot{y} = Q(x, y), \tag{1}$$

where the dot denotes derivative with respect to an independent real variable t, usually called the *time*. The *degree* of the polynomial differential system (1) is the maximum of the degrees of the polynomials $P(x, y)$ and $Q(x, y)$.

The origin $O = (0, 0)$ of $\mathbb{R}^2$ is a *singular point* for system (1) if $P(0, 0) = Q(0, 0) = 0$.

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