

A normal form of your dynamical system

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Generally, the lowest order, most important, terms are near the end of each expression.

off echo;

Specified dynamical system

$$\dot{x}_1 = \varepsilon y_1^2$$

$$\dot{y}_1 = \sigma w_1 - y_1$$

off echo;

Time dependent normal form coordinates

$$y_1 = \sigma e^{-1t} \star w_1 + O(\varepsilon^4, \sigma^2) + Y_1$$

$$x_1 = \sigma \varepsilon (-e^t \star w_1 Y_1 - e^{-1t} \star w_1 Y_1) - 1/2 \varepsilon Y_1^2 + O(\varepsilon^4, \sigma^2) + X_1$$

Result normal form DEs

$$\dot{Y}_1 = O(\varepsilon^5, \sigma^3) - Y_1$$

$$\dot{X}_1 = \sigma^2 \varepsilon e^{-1t} \star w_1 w_1 + O(\varepsilon^5, \sigma^3)$$