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Nilpotencies and realizability in delayed nonlinear oscillators

The effects of delayed feedback terms on nonlinear oscillators have been extensively studied, and have important applications in many areas of science and engineering. We study a particular class of second-order delay-differential equations near a point of triple-zero nilpotent bifurcation. Using center manifold and normal form reduction, we show that the three-dimensional nonlinear normal form for the triple-zero bifurcation can be fully realized at any given order for appropriate choices of nonlinearities in the original delay-differential equation.