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PAINLEV ANALYSIS, SYMMETRY AND INTEGRABILITY ASPECTS OF DAMPED NONLINEAR OSCILLATOR EQUATION

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Identifying integrable nonlinear differential equations and exploring their underlying solutions is one of the challenging problems in nonlinear dynamical systems. Different methods have been proposed in order to identify new integrable cases and to understand the underlying dynamics associated with the finite dimensional nonlinear dynamical systems. The most widely used methods include Painlev analysis, Lie symmetry analysis, Noethers theorem and direct linearization etc. In this paper, we consider a general damped second-order nonlinear ordinary differential equation of the form $\ddot{x} + (k_1 x^q + k_2)\dot{x} + k_3 x^{2q+1} + k_4 x^{q+1)+\lambda x=0}$ where over dot denoted differentiation with respect to t, and ${k_i}^s, i = 1, 2, 3, 4, \lambda$ and q are arbitrary parameters. For $q = 1$, we carry out the Painlev analysis, obtained the symmetry and then integrability. We repeat the analysis for $q = 2$ and finally for $q = arbitrary$. It is interesting to see that the above equation includes a large number of physically important nonlinear oscillators such as the anharmonic oscillator, force-free Helmholtz oscillator, force-free Duffing oscillator, force-free Duffing -van der Pol oscillator, modified Emden type equation and its hierarchy. Our results show several new equations which have signature of integrability.

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