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Homoclinic bifurcation in a three degrees-of-freedom system with dry friction

Mariusz Holicke, Jan Awrejcewicz

ABSTRACT

We are focused on analytical prediction of homoclinic bifurcations in a non-smooth self-excited three degrees-of-freedom (DOF) mechanical system with dry friction. Applied Melnikov's technique [1] in extended and modified version [2] is usually used to find chaos occurrence after the destruction of a homoclinic orbit. However, dry fiction changes qualitatively a picture of dynamical behaviour owing to non-smooth friction dependence on moving bodies. Classical Melnikov's technique has been applied firstly by the authors to analyse 1-DOF mechanical system in reference [3]. In this work the Melnikov-Gruendler method [2] is used to study homoclinic bifurcations in the belt moving with a constant velocity. It is assumed that a relative contact between three rigid bodies and the belt yields frictional forces, which are approximated by the modified third order polynomial function.

Owing to the carried out analytical computations, algebraic relations of critical parameter values of the homoclinic bifurcation occurrence are derived. The obtained results are verified using numerical computations (bifurcation diagrams, Poincaré maps and phase plots).

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[2] Gruendler J., The existence of homoclinic orbits and the method of Melnikov for systems in R^n. *SIAM J. Math. Anal.*, 5(16), 1985, 907-931.
[3] Awrejcewicz J., Holicke M.M., Melnikov's method and stick-slip chaotic oscillations in very weakly forced mechanical systems. *Int. J. Bifurcation & Chaos*, 9(3), 1999, 505-518.