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Using Dynamic Vibration Absorber for Stabilization of a Double Pendulum Oscillations

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Abstract: In this paper a stability problem for double pendulum is discussed. A damping device of passive type is used to stabilize small free oscillations of perturbed system. The simplified approach is suggested to prove the asymptotic stability of equilibrium.

Keywords: *double pendulum; dynamic vibration absorber; asymptotic stability; Lagrange function.*

Mathematics Subject Classification (2010): 34C46, 34D20, 70E50, 70E55, 70K20.

1 Introduction

The double pendulum may be considered as a simplified model of the coupled rigid bodies and finds wide use in engineering and technology. Both mathematical and physical interest to this model arises from the phenomena of its motion. Although this motion is described by rather simple ODE system, the pendulum exhibits the dynamical behavior which may be complex and unpredictable [1,2]. In particular, the motion of the double pendulum has the ability of ***beats*** and is strongly sensitive to the initial perturbations. These perturbations may provoke an increased amplitude of the second limb oscillations and, as a result, the switch from regular regime to chaotic one [3,4].

The problem of elimination or reduction of the undesired vibration in various technical systems has a long history and great achievements [5], mostly during the last century. For this purpose the damping devices are used, which may be divided into active and passive dampers. The classical example of passive damper is a dynamic vibration absorber (DVA) [6,7] or vibration neutralizer. It represents the mechanical appendage comprising inertia, stiffness, and damping elements and is connected to a given structure, named herein the primary [5] or original [8] system, with the aim to absorb the excessive vibratory energy. A DVA may be used both in cases of free oscillations and vibrations caused by harmonic excitations. For the case of a simple pendulum, DVA was used in papers [8,9].

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