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The influence of the inductance on the nonideal vibrations of a pendulum coupled to a DC motor

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Abstract: The present analysis focuses on the dynamics of a pendulum vertically vibrated by a DC motor. The pendulum moved on the support by vertical harmonic displacement is extensively studied in the literature because of different types of motion including chaos. When the pendulum is vibrated by a DC motor the system is considered non-ideal and it is common a synchronization in frequency between the pendulum and the motor, where the pendulum exhibits either oscillation or rotation. The analysis in the present text varied the value of the inductance from zero to 1 million times the value of a real motor, but the basins of attraction with rotation and oscillation nearly maintained its features. The influence of the inductance has a major effect while the motor accelerates, which could cause an uncertain during the capture by a coexisting attractor. However, the results demonstrated the influence of inductance in this configuration is minimum.

Keywords: inductance, DC motor, pendulum, non-ideal

1. Introduction

The parametrically excited pendulum is vastly analysed in literature. In this situation, the pendulum may have chaotic motion, rotation, oscillation, periodic mixture of rotation and oscillation and the fixed point, where the pendulum is at rest. Basins of attraction for parametricaly excited pendulum with crank-slider mechanism were performed and published in [1]. Recently, non-ideal analyses have been gaining space in literature. The system is called non-ideal when the masses involved interfere on the dynamics of the source of energy. The case simulated for the present paper is a pendulum vertically excited by a DC motor with 250 W using a crank-slider mechanism. The motivation of the present analysis is the conclusion in [2] where the authors consider of high relevance the inductance for the results where a cart is moved by a DC motor. On the other hand, a pendulum horizontally moved by a DC motor with a pendulum had its dynamics studied in [3] neglecting the DC motor inductance.

2. Results and Discussion

The results pointed we do not have changes in the types of motion when the inductance is varied. The types of motion found are oscillations in 2-period represented in green colour in Figs. 1 (a,b,c,d).

In black and red, there are two different rotative 1-period attractors where the red has a positive speed and black a negative speed. The Fig1e represents the mechanism with the pendulum, DC motor and crank-slider. The Eq.(1) represent the electric equation of the motor and the Eq.(2) represent the torque supplied by this DC motor. The Fig.1a demonstrate the basin of attraction when the inductance is neglected in the electric equation. The Fig1(b) presents the basin of attraction with the real value of inductance found in the manufacturer catalogue. This value for inductance is 0.161x10^{-3} Henry from a motor with 250 Watts. In Fig.1c the value for the inductance is 1000 times the value from catalogue and in Fig.1 d, the value is one million times the value from the catalogue.

$$V = L\frac{di}{dt} + Ri + K_E\theta \quad (1)$$

$$M_{motor} = K_T \cdot i \quad (2)$$

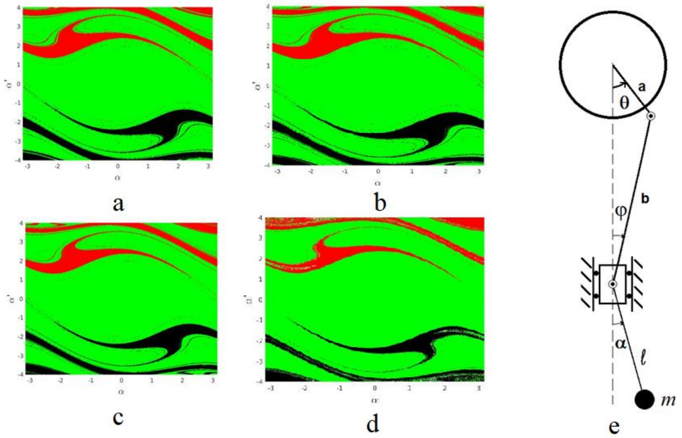

Fig. 1. Basins of attraction. a) No inductance b) Real inductance c)1000 times the inductance d) One million times the inductance e) The figure of the mechanism

3. Concluding Remarks

The results led to conclude that the inductance was not relevant in these mechanism working under the parameters set. The actual idea concerning the inductance is that it is not relevant when the speed of motor does not vary considerable.

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