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Frequency-dependent instabilities in Ziegler's double pendulum interacting with a damped oscillator

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In the book by Ziegler [1], attention has been given to a discrete mechanical system featuring two rigid bars connected by a viscoelastic hinge, pinned at one end and subjected at the free end to a concentrated load, designed to be parallel with the latter bar. Depending on the loading conditions, such structure is able to exhibit flutter and divergence instabilities [2].

More recently, Cazzolli et al. [3] examined an extension of such structure in which the double pendulum is mounted on a translating cart and in which the "follower" loading, conceptualized by Ziegler, is concretized as the reaction force to a nonholonomic constraint. By having recourse to theory of bifurcations [4], they predict both theoretically and numerically the onset of stable limit cycles in the phase plots for the two angles characterizing the double pendulum.

Given the premises above, in this presentation we aim at discussing the consequences of "un-fixing" the plate on which the cart, connected to the double pendulum, can slide: indeed, by assuming the plate to be linked at a fixed wall through a viscoelastic spring, we show that the ratio between the fluttering frequency and the frequency of the plate's oscillations can significantly influence the dynamics and the instability properties of the overall system. To do this, we summarize the main findings of [5] by merging together theoretical arguments of dynamical systems [4] with computational techniques of nonholonomic systems [6],

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References

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