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Dynamical Behaviors of Fractional-Order Selkov Model and Its Discretization

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Abstract: In this work, we study the dynamics of a fractional-order Selkov model, which is a classical mathematical model describing glycolysis, and its corresponding discretized version. First, non-negativity, existence and uniqueness of the solution for the model are discussed. We also investigate the local stability and the existence of a Hopf bifurcation. The discrete fractional-order model is shown to exhibit very rich behaviors and when considering the step size as a control parameter, a flip bifurcation, Neimark-Sacker bifurcation and chaos are obtained. Finally, numerical simulations are carried out to verify the correctness of the theoretical results obtained.

Keywords: *fractional order; Selkov model; local stability; bifurcations; discretization.*

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1 Introduction

Glycolysis is the first step in the breakdown of glucose to extract energy for cellular metabolism, it is present in nearly all living organisms. After many years of experimental observations, Higgins [1] was the first to use mathematical modelling to understand the process, he presented a model to explain sustained oscillations in the yeast glycolytic system. His model, however, has no limit cycle for those values of its parameters with which self oscillations are observed experimentally. In 1968, Selkov [2] introduced an alternative mathematical model able to well reproduce the glycolytic oscillations in yeast, it was shown that the Selkov model exhibits a Hopf bifurcation and thus there exist parameter values for which it has a periodic solution. This model has sparked a number

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