

## **Hopf bifurcation analysis of immune response against pathogens interaction dynamics with delays**

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**ABSTRACT.** The aim of this paper is to study the steady states of the mathematical models with delays which describe pathogen-immune dynamics of many kinds of infectious diseases. In the study of mathematical models of infectious diseases it is an important problem to predict whether the infection disappears or the pathogens and the immune system persist. The delays are described by the memory function that reflect the influence of the past density of pathogen in blood. By using the coefficients of delays, as a bifurcation parameter, the models are found to undergo a sequence of Hopf bifurcation. The direction and the stability criteria of bifurcation periodic solutions are obtained by applying the normal form theory and the center manifold theorems. Some numerical simulation examples for justifying the theoretical results are also given.

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