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Geometric stability switch criteria in delay differential systems with delay dependent parameters. (English) Zbl 1013.92034

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Summary: In most applications of delay differential equations in population dynamics, the need of incorporation of time delays is often the result of the existence of some stage structure. Since the through-stage survival rate is often a function of time delays, it is easy to conceive that these models may involve some delay dependent parameters. The presence of such parameters often greatly complicates the task of an analytical study of such models. The main objective of this paper is to provide practical guidelines that combine graphical information with analytical work to effectively study the local stability of some models involving delay dependent parameters.

Specifically, we show that the stability of a given steady state is simply determined by the graphs of some functions of τ which can be expressed explicitly and thus can be easily depicted by Maple and other popular software. In fact, for most application problems, we need only look at one such function and locate its zeros. This function often has only two zeros, providing thresholds for stability switches.

The common scenario is that as time delay increases, stability changes from stable to unstable to stable, implying that a large delay can be stabilizing. This scenario often contradicts the one provided by similar models with only delay independent parameters.

MSC:

92D25 Population dynamics (general)
34K20 Stability theory of functional-differential equations
34K18 Bifurcation theory of functional-differential equations

Keywords:

delay differential equations; stability switch; characteristic equations; stage structure; population models

Software:

Maple

Full Text: DOI