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Periodic Solutions of a Singularly Perturbed State Dependent DDE

We consider the singularly perturbed delay differential equation (DDE)

$$\varepsilon \dot{u}(t) = -\gamma u(t) - \sum_{i=1}^{2} \kappa_i u(t - a_i - c u(t)),$$

which has two linearly state-dependent delays. We show how to construct periodic solutions in the singular limit using geometric arguments. This allows us to construct the bifurcation diagram in the singular limit. We show that the bifurcation structures persist for small ε by studying the bifurcation structures numerically in that case. We find fold bifurcations and resulting regions of bistability on the principal branch. We also show that interaction between the delay terms determines the shape of the periodic solutions and branches. Finally, we show how the alignment of the branches of periodic solutions depends on the ratio a_2/a_1 of the delays at the trivial solution $u = 0$.