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Efficient numerical methods for coupled singularly perturbed systems of reaction-diffusion type[†]

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SUMMARY

In this talk we consider coupled singularly perturbed systems of reaction-diffusion type, which can be time dependent or stationary. It is well know that, when the positive diffusion parameters, which can take arbitrary small values, have different orders of magnitude, in general coupled boundary layers appear at the boundary of the spatial domain. So, to solve efficiently this type of problems, uniformly convergent methods, for which the error is bounded independently of the value of the diffusion parameters, are needed.

To construct uniformly convergent methods, the spatial discretization of the continuous problem uses classical finite difference schemes, which are defined on special nonuniform meshes of Shishkin type, condensing the grid points in the boundary layer regions. The time discretization uses the classical Euler implicit method or additive (splitting) schemes defined on a uniform mesh. Then, the fully discrete method gives accurate approximations to the solution for any value of the diffusion parameters.

Some numerical results are presented, corroborating in practice the theoretical results. The numerical results show the advantage of each one of the methods, both in terms of computational cost and order of uniform convergence.

Keywords: coupled systems, singular perturbation, special meshes, uniform convergence

AMS Classification: 65N05, 65N06, 65N10

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