SEMINARIO

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Splitting methods for solving one dimensional parabolic singularly perturbed systems with an attractive interior turning point and a discontinuous source term

Abstract: In this work we deal with studying and solving one dimensional parabolic singularly perturbed systems with two equations of convection-diffusion type, where the convective term provokes an attractive interior turning point; besides, we assume that the source term has a jump discontinuity at this point; under these conditions the solution of these systems contains, in general, internal boundary layers which are difficult to resolve. We will focus firstly our attention on the case that the small diffusion parameter is the same in all equations of the system. The numerical method proposed here to solve these problems combines the upwind scheme, which is constructed on a special nonuniform Shishkin mesh, together with a standard splitting method of first order. We prove that the numerical algorithm resulting from this combination is uniformly convergent with respect to the diffusion parameter, reaching first order with respect to the time variable and almost first order with respect to the spatial variable. A remarkable quality of our proposal is that it is easily extendable to systems with more components; moreover, a strong reduction in the computational cost of this algorithm is observed, if we compare it with classical methods used to solve the same type of problems. Some numerical results for different test problems are shown and they corroborate in practice the uniform convergence and the efficiency of the numerical method, in agreement with the theoretical results. As well, we show, only numerically, that our technique can be extended to the cases where the diffusion parameters at the equations of the system have different scales.

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