The authors represent an ongoing effort to develop successful methods for solving flow problems with multiscale behavior. They represent a new approach in finite element methods to solve singularly perturbed convection–diffusion problems. Standard methods for these problems perform poorly because of the presence of sharp boundary/or internal layers in the solution. In the proposed approach, a Petrov–Galerkin finite element method in which the test function space is exponentially fitted is used.

The case of one dimensional problems of this proposed approach is similar to that proposed by [P.W.Hemker, A numerical study of stiff two–point boundary problems, Mathematical Center Tracts, vol. 80, Mathematisch Centrum, Amsterdam, 1977].

The test function space is modified to capture the solution of a discretized dual problem. The dual problem is posed in such a way that the weighted error at the interelement boundaries is minimized. The solution of this dual problem is exponential. Hence, the space of test functions is chosen in such a way that we get a better approximation to the dual solution.

These modified test functions fit into a hierarchical framework resulting in the development of a stable higher–order method. Various numerical tests are given .