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math@tubitak.gov.tr

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Asymptotic Analysis of Singularly Perturbed Abstract Evolution Equations in Banach and Hilbert Spaces

Dialla KONATE
Virginia Tech
Department of Mathematics
Blacksburg, VA, 24061 USA
e-mail: dkonate@math.vt.edu

Abstract: In the current paper, we are concerned with the study of abstract linear evolution equations in Banach spaces in which the time derivative term is multiplied by a small parameter, say ε. Such equations arise in the study of radiative transfer and neutron transport in Nuclear Physics. Following works by Krein (cf [9]) and others, Mika (cf [12,13,14,15]) using either the Hilbert method or the Compressed method has shown that the solution of the given singularly perturbed equation may be approximated upto any prescibed order by a sum of two asymptotic expansions that are the outer expansion that is valid ``far away'' from the Initial layer and the Inner expansion which vanishes out of a certain neighborhood of the Initial layer. Since the terms of the Inner expansion are usually difficult to calculated, these higher order asymptotic approximations often remain formal. The main objectives of the current paper are: - to locate precisely the Initial layer (cf [7,8]) - to show that making use of the concept of corrector as set by Lions (cf [11]) the outer expansion alone (at the exclusion of the inner expansion) suffices to achieve an approximation upto any prescribed order of precision. Moreover, these results are reached under hypotheses that are weaker than those usually considered in the literature. The asymptotic solutions are worked out either in the general situation of Banach spaces or in the case of Hilbert spaces.

Key Words: Singular Perturbation, Asymptotic Expansion, Banach space, semigroup, evolution equation, Initial Layer, Corrector, radiative transfer, neutron transport.

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