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Solution of Singularly Perturbed Differential Difference Equations Using Liouville Green Transformation

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Abstract : The class of differential-difference equations which have characteristics of both classes, i.e., delay/advance and singularly perturbed behaviour is known as singularly perturbed differential-difference equations. The expression 'positive shift' and 'negative shift' are also used for 'advance' and 'delay' respectively. In general, an ordinary differential equation in which the highest order derivative is multiplied by a small positive parameter and containing at least one delay/advance is known as singularly perturbed differential-difference equation. Singularly perturbed differential-difference equations arise in the modelling of various practical phenomena in bioscience, engineering, control theory, specifically in variational problems, in describing the human pupil-light reflex, in a variety of models for physiological processes or diseases and first exit time problems in the modelling of the determination of expected time for the generation of action potential in nerve cells by random synaptic inputs in dendrites. In this paper, we envisage the use of Liouville Green Transformation to find the solution of singularly perturbed differential difference equations. First, using Taylor series, the given singularly perturbed differential difference equation is approximated by an asymptotically equivalent singularly perturbation problem. Then the Liouville Green Transformation is applied to get the solution. Several model examples are solved, and the results are compared with other methods. It is observed that the present method gives better approximate solutions.

Keywords : difference equations, differential equations, singular perturbations, boundary layer
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