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Asymptotic behavior of solutions of singular integro-differential equations

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Abstract

Consider the following integro-differential equation:

$$L_\varepsilon y \equiv \varepsilon^2 y'''' + \varepsilon A(t) y'' + B(t) y' + C(t) y = F(t) + \int_0^1 [H_0(t, x) y(x, \varepsilon) + H_1(t, x) y'(x, \varepsilon)] dx \quad (1)$$

with boundary conditions:

$$y(0, \varepsilon) = \alpha, \quad y(1, \varepsilon) = \beta, \quad y'(1, \varepsilon) = \gamma, \quad (2)$$

where $\varepsilon > 0$ is a small parameter, α, β, γ are known constants and independent of ε .

The following conditions are required in the paper.

I. $A(t), B(t), C(t), F(t)$ are sufficiently smooth functions on the interval $[0, 1]$, i. e. differentiable as many times as needed for our consideration. In the domain $D = (0 \leq t \leq 1, 0 \leq x \leq 1)$, function $H_i(t, x), i = 0, 1$ are sufficiently smooth.

II. $B(t) \neq 0, 0 \leq t \leq 1$.

III. The roots $\mu_1(t) \neq \mu_2(t)$ of additional characteristic equation $\mu^2 + A_0(t) \cdot \mu + A_1(t) = 0$, satisfy the following inequalities $Re \mu_1(t) < 0, Re \mu_2(t) > 0$.

A similar problem for differential equations considered in [1]. It is proved that the solution of the problems (1) and (2) at $t = 0$ has the phenomenon of the zero order and at $t = 1$ has the phenomenon of the first-order initial jump, i.e.

$$y(0, \varepsilon) = O(1), \quad y'(0, \varepsilon) = O\left(\frac{1}{\varepsilon}\right), \quad y''(0, \varepsilon) = O\left(\frac{1}{\varepsilon^2}\right),$$

$$\text{and } y^{(i)}(1, \varepsilon) = O(1), \quad i = 0, 1, \quad y''(0, \varepsilon) = O\left(\frac{1}{\varepsilon}\right), \quad \varepsilon \rightarrow 0.$$

*This study is a joint work with A. E. Mirzakulova .

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