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Problem with Integral Conditions for Polycaloric Equation

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In the strip $\Omega = \{(t, x) \in \mathbb{R}^2 : t \in (0, T), x \in \mathbb{R}\}$, $T > 0$, we consider the following problem

$$\left[\frac{\partial}{\partial t} - a\left(\frac{\partial}{\partial x}\right)\right]^n U(t, x) = 0, \tag{1}$$

$$\int_0^T t^k u(t, x)dt = \varphi_k(x), \quad \overline{k = 0, n-1}, \tag{2}$$

where $a\left(\frac{\partial}{\partial x}\right)$ is a differential expression of generally infinite order with entire symbol $a(\lambda)$.

According to the Differential-symbol method [1], we construct the solution of problem (1), (2) in the form

$$U(t, x) = \sum_{k=0}^{n-1} \varphi_k\left(\frac{\partial}{\partial \lambda}\right)\left\{M_k(t, \lambda)e^{\lambda x}\right\}\Bigg|_{\lambda=0},$$

where $M_k(t, \lambda)$, $m = \overline{0, n-1}$ is a solution of the equation

$$\left[\frac{d}{dt} - a(\lambda)\right]^n M_k(t, \lambda) = 0,$$

that satisfies the integral conditions

$$\int_0^T t^j M_k(t, \lambda)dt = \delta_{jk}, \quad \overline{k = 0, n-1},$$

where δ_{jk} is the Kronecker symbol.

[1] P.I. Kalenyuk, Z.M. Nytrebych, *Generalized scheme of separation of variables. Differential-symbol method*, Publishing House of Lviv Polytechnic National University, Lviv, 2002.