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Section:

10. Partial Differential Equations

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A nonlocal problem for the hyperbolic equation

Certain problems, arising in modern physics, can be reduced to nonlocal problems for the second order partial differential equations. Consider the problem for the hyperbolic equation

$$Lu \equiv u_{xx} + (Au)_x + (Bu)_y + Cu = f(x,y)$$

in the domain $D = \{(x,y): \quad 0 < x < a, \quad 0 < y < b\}$ with the following conditions: $\int_0^a u(x,y)dx = \int_0^b u(x,y)dy = 0$. It is to be note that if integral conditions are not homogeneous we can easily reduce them to homogeneous by constructing a function satisfying the same integral conditions. We define the function space $\tilde{L}_2 = \{u : \quad u \in L_2(D), \quad \int_0^a udx = \int_0^b udy = 0\}$. The weak solution of the posed problem is a function $u(x,y) \in \tilde{L}_2(D)$ such that for every $v(x,y) \in \tilde{L}_2(D), \quad (u, L^* lv)_{L_2} = (f, lv)_{L_2}$, where $lv \equiv \int_0^y \int_0^x v(t,\tau)dtd\tau$. The existence and uniqueness of weak solution are proved. In this end of view two sided a priori estimate is derived. To show the existence of the solution the Galerkin method is used.