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Чернівецький національний університет
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ДИФЕРЕНЦІАЛЬНО-ФУНКЦІОНАЛЬНІ РІВНЯННЯ ТА ЇХ ЗАСТОСУВАННЯ

Матеріали міжнародної наукової конференції, присвяченої 80-річчю від дня народження професора В.І. Фодчука (1936-1992)

28-30 вересня 2016 рік

DIFFERENTIAL-FUNCTIONAL EQUATIONS AND THEIR APPLICATION

Чернівці – 2016

In this talk we consider important classes of one dimensional environments, bending stiffness of which can be neglected. It is impossible to apply approximate analytical method of solution of mathematical models of dynamic processes. So justification of existence and uniqueness of solutions, carried out a qualitative their evaluation, based on numerical analysis are considering. Also the features of dynamic processes of some of examined class of systems are analyzed. Methods of qualitative study of oscillations for restricted and unrestricted bodies under the influence of the resistance forces, described in the talk are based on the general principles of the theory of nonlinear boundary value problems - Galerkin method and the method of monotonicity [1].

Scientific novelty consists in generalization these methods of studying for nonlinear problems at new classes of oscillating systems, justification of solution correctness for specified mathematical models that have practical application in real engineering vibration systems [2].

[1] Pukach P. Ya., *Qualitative research methods of mathematical model of nonlinear vibrations of conveyor belt*, Journal of Mathematical Sciences, **198**, Issue 1, (2014), pp. 31-36.

[2] Pukach P. Ya., Kuzio I. V., *Nonlinear transverse vibrations of semi-infinite cable with consideration paid to resistance*, Scientific Bulletin of National Mining University, **3**, (2013), pp. 82-86.

Investigation of non-linear boundary value problems by parametrization at multiple nodes

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Here, we study the absolute continuous solution of non-linear boundary value problem

$$\frac{du(t)}{dt} = f\left(t, u(t)\right), \ t \in [a, b], \quad \Phi(u) = d, \tag{1}$$

where $f : [a,b] \times D \to \mathbb{R}^n, D \subset \mathbb{R}^n$ is a Caratheodory function, $d \in \mathbb{R}^n$ is a given vector, and Φ is a vector functional on the space of absolutely continuous functions (generally speaking, non-linear).

Following the idea used in numerical methods for approximate solution of initial value problem for ordinary differential equations, let us choose $N+1$ grid points $t_0 = a, t_k = t_{k-1}+h_k, k = 1,2,...,N-1, t_N = b$, where $h_k,\ k = 1,2,...,N-1$, are the corresponding step sizes.

The idea that we are going to use suggests to replace the original non-local problem (1) on each interval $[t_{k-1}, t_k], k = 1,2,...,N$ by a suitable family of two initial value problems:

$$\begin{aligned} &\frac{dx^{(k)}}{dt} = f\left(t, x^{(k)}\right), \ t \in [t_{k-1}, t_k], \\ &x(t_{k-1}) = z^{(k-1)}, \ x(t_k) = z^{(k)}, k = 1,2,...,N, \end{aligned} \tag{2}$$

where vectors $z^{(k)} = col(z_1^{(k)}, z_2^{(k)}, ..., z_n^{(k)}),\ k = 0,1,2,...,N$ will be considered as unknown parameters whose values are to be determined.

Due to the form of the transformed additional conditions, it is natural to apply to (2) the successive approximation techniques similar to those used in [1], [2]. The specific properties of restrictions Φ being transferred to so called determining algebraic equations.

[1] Ronto A., Ronto M. and Shchobak N., *Notes on interval halving procedure for periodic and two-point problems*, Boundary Value Problems, (2014), pp. 20.

[2] Ronto A., Ronto M. and Varha J., *A new approach to non-local boundary value problems for ordinary differential systems*, Applied Mathematics and Computation, (2015), pp. 689-700.

Center conditions for non-linear differential systems

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