PROCEEDINGS

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Edited by:

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Anđelka Hedrih
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CAN A MODIFIED MATHIEU - DUFFING OSCILLATOR SIMULATE THE DYNAMIC TRANSMISSION ERROR OF A GEAR PAIR?

The scope of this paper is to introduce a novel, single-DOF, non-linear model for fast dynamic simulation of gear-pair dynamic transmission error based on the Mathieu – Duffing oscillator. Although considerably simpler than existing models for gear-tooth engagement, the presented model is not phenomenological and the selection of the constitutive oscillator parameters is discussed and explained. Both single and double tooth contact are taken into consideration with varying gear mesh stiffness values. The Mathieu – Duffing equation is modified by introducing phase shift on the periodical term to better interpolate mesh stiffness variations along the action line. The model is used to simulate the dynamic transmission error occurring in gear-pairs with constant excitation (input torque) and variable backlash values, and successfully describes the observed pseudo-chaotic response of such systems exhibiting distinct limit cycles. The results presented in this paper refer to low-torque high rotational speed applications that are known to produce intense rattling and intermittent tooth contact in various circumstances. Comparison of the calculated transmission error values between the presented model and existing exhaustive single or multi-DOF mathematical models is performed using Matlab/ Simulink to evaluate the accuracy of the derived results. The presented model is a few orders faster in run-time than conventional simulations. Phase diagrams are plotted and compared for distinct input torque values, exhibiting high interpolation accuracy of the resulting transmission error. The findings of the current study are discussed extensively in order to promote the benefits of the presented method, elaborate on its potential applications and propose alternative, more accurate models for fast prediction of the transmission error of gear-pairs.

M1c: M. Minglibayev, A. Prokopenya, O. Baisbayeva

EVOLUTION EQUATIONS OF TRANSLATIONAL-ROTATIONAL MOTION OF A TRIAXIAL BODY WITH CONSTANT DYNAMICAL SHAPE AND VARIABLE SIZE IN A NON-STATIONARY CENTRAL GRAVITATIONAL FIELD

The translational-rotational motion of a triaxial body with constant dynamic shape and variable size and mass in a non-stationary Newtonian central gravitational field is investigated. Differential equations of motion of the body in the relative coordinate system with origin at the center of the second non-stationary spherical body are obtained. The axes of the own coordinate system of the non-stationary triaxial body are directed along the principle axes of inertia of the body and we assumed that in the course of evolution their relative orientation remains unchanged. Differential equations of translational-rotational motion of a non-stationary triaxial body were derived in Jacobi osculating variables. Differential equations of the unperturbed translational-rotational motion are integrated by the Hamilton-Jacobi method. In this case, the translational motion of the center of mass of a non-stationary triaxial body is described by the osculating elements of aperiodic motion on quasiconic section. The osculating motion of Euler for an axisymmetric non-stationary body characterizes rotational motion around the center of mass. An analytical expression for the force functions of the Newtonian interaction of a triaxial body with variable mass and size with a spherical body of variable size and mass are given. There have been obtained canonical equations of perturbed motion in analogues to the Delaunay-Andoyer elements. The perturbing function are expanded in power series in terms of the Delaunay-Andoyer

elements up to the second harmonic element inclusive. In principle, these expansions make it possible to write out the expression for the perturbing function with any necessary accuracy. The evolution equations of the translational-rotational motion of a non-stationary triaxial body are obtained in the osculating elements of Delaunay-Andoyer.

M1d: Ljubinko B. Kevac, Mirjana M. Filipović, Živko D. Stikić

CONSTRUCTIVE STABILITY (INSTABILITY) OF THE SYSTEM

In this paper, the structural stability or instability of the system is analyzed. This phenomenon is shown in a very simple way example: construction of a winch for the cable winding/unwinding–CWU process. In first, we have presented, analyzed, and defined of the phenomenon of nonlinear and pulsed nature of the dynamic process of the CWU on the standard winch. This process is characterized with sudden and abrupt jumps of dynamic variables which describe the CWU process. Because of that, we have named this concept: process of the rope „jumpy" nonlinear in one row radially multilayered CWU on the winch. Because of the easier understanding of this „jumpy" concept of the CWU process, we have first analyzed this concept under idealized circumstances - when the rotational speed of the winch is constant. CWU system for multi-row radial and axial CWU process is analyzed also. In first authors use CWU on the first layer, without the possibility and need for using the second layer, for implementation of their CWU system. The cable is only axially furled around the winch. Finally structural stability of the second and third layer of CWU process is analyzed. To show that this process is even more complex in the real working conditions (when it is part of a complex system). New constructive solutions of winches for single-row radial multi-layered smooth CWU on a winch are described. Two new structural solutions of winches have been defined. The nonlinear phenomenon of smooth CWU process on the winch by using one of the two proposed constructive solutions has been defined and analyzed. To facilitate understanding of this concept, the CWU process on only one winch has been analyzed. The obtained variables which characterize the kinematics of the smooth CWU process are nonlinear and smooth. This result is important because the systems for smooth CWU process on the winch could be parts of any cables driven mechanism.

M1e: Marina Trajković-Milenković, Otto T. Bruhns

LOGARITHMIC RATE IMPLEMENTATION IN NUMERICAL ANALYSIS OF FINITE MONOTONIC AND SMALL CYCLIC ELASTOPLASTIC DEFORMATIONS

The numerical implementation and validation of the self-consistent Eulerian constitutive theory of finite elastoplasticity, based on the logarithmic rate and the additive decomposition of the natural deformation rate (stretching), have been the main tasks of this work. For that purpose the special software has been developed and implemented in the commercial software ABAQUS/Standard via the user subroutine UMAT. The implemented constitutive relation for finite elastoplasticity is based on the hypo-elastic relation and the inelastic INTERATOM model. The obtained numerical results have been compared with the experimental records. The proposed constitutive model has been proved as reliable for monotonic deformations while for cyclic deformations some improvements remain to be implemented. The directions for improvements have been given as well.