MULTI FREQUENCY AND INFINITE-FREQUENCY REGIMES AND LYAPUNOV EXPONENTS AS THE MEASURES OF THE HYBRID SYSTEM DYNAMIC INTEGRITY

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Abstract. *A review of author's research results [1-6] in area of dynamics of coupled subsystems and coupled dynamical processes into hybrid systems is presented.* ***Also,*** *a discussion on what are the basic properties and concepts of integrity of dynamical oscillatory systems with respect to the structure as well as to the number of frequency oscillations. The main research problem for the study of integrity of dynamical systems is to recover measures of integrity of dynamical system structures and dynamical system processes by which we can conclude that system dynamics is stable, whether the system possesses integrity of structures or whether that system loses integrity of component dynamics.*

The sets of two or many coupled partial as well as partial integro-differential equations, and also partial fractional order differential equations of transversal vibrations of an elastically, as well as visco-elastic, and also creep connected double beam system, as well as double plate systems, and also axially moving multi (double of three) belt system with or without discontinuity in the distributed layer between deformable bodies have been derived. The beam's as well as plate's materials, and also belt's materials are elastic or visco-elastic or creeping and constitutive relations of stress-strain states are expressed through members with integral parts or of the fractional order derivatives.

By using two examples of free transversal vibrations of the elastically as well viscoelasticly connected double-plate systems and corresponding system with a discontinuity in elastical or viscoelastic connection, we show some basic properties of the integrity of basic dynamical system oscillations. The integrity of corresponding dynamical processes in the behaviour of the whole system and its subsystems or in component processes and in response of the whole system with respect to corresponding system with discontinuity have been studied by using methods of Bernoulli's particular integral and Lagrange's method of constants variation. It is shown that one-frequency and two frequaency regimes changes into infinite number-frequency regimes induced by discontinuity in the system, which represents the loss of integrity of the system structure and marks the appearance of the loss of integrity of corresponding two frequency processes.

Depending on the numbers of the connected deformable bodies with same contours and boundary conditions in the every of the infinite numbers of the eigen amplitude modes appear corresponding set of the corresponding numbers of the eigen circular frequencies. When in the distributed layer between deformable bodies exists a small discontinuity, then appear connections between all of infinite number of the eigen amplitude modes and vibrations in the every of the eigen amplitude modes appear infinite number frequency vibration regimes. For corresponding simple initial conditions in the one eigen amplitude mode appear not finite number frequency vibrations but infinite number frequency, and this vibration regime is indicator for identification of the discontinuity in structures (or damage of structure) a)s well as hybrid dynamics of the vibrations.

Key words: Coupled subsystems, coupled dynamics, hybrid, deformable body, beams, plate, belsts, multi frequency, infinite number frequency, energy transfer, coupled modes, Lyapunov exponents.

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