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Mathematical model of a multi-parameter oscillator based on a core-less three-phase linear motor with skewed coils

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Abstract: This paper uses the example of a three-phase core-less linear motor to create a mathematical model of single-dimension multi-parameter oscillator. The studied linear motor consists of: a stator, an U-shaped stationary guide-way with permanent magnets placed askew to the motor's movement's direction; and a forcer, a movable set of three rectangular coils subjected to alternating external electrical voltage. The system's parameters are both mechanical (number of magnets and coils, size of magnets, distances between magnets, size of coils) and electromagnetic (auxiliary magnetic field, permeability, coil's resistance). Lorentz force allows for the transition from electromagnetic parameters to mechanical force and Faraday's law of induction creates a feedback between the forcer's speed and coils voltage. An Ampere's model of permanent magnet is used to determine the simplified function of auxiliary magnetic field distribution throughout the stator. In the model the external voltage applied to each coil serves as the excitation while displacement of the forcer is the output parameter. The solution to the introduced mathematical model of the system is compared with the experimental results showing a good coincidence.

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