

# Development of a model of an electric analogue of electromechanical systems taking into account mechanical losses

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## ABSTRACT

According to the mathematical statement presented in [1], the problem on natural vibrations of piece-wise homogeneous electroelastic or electro-viscoelastic bodies with external electric circuits is quite efficient for optimization of dynamic properties of electromechanical systems such as structures with attached piezoelectric elements shunted with external electric circuits. This problem can be solved numerically using the finite element method. External electric circuits are a set of electric elements with lumped parameters. Connection of an external circuit to a system with distributed parameters leads to increase in time and computational costs provided that the full mathematical statement [1] is used for obtaining a numerical solution to the natural vibration problem.

In mechanics, there are well-known approaches that allow representing mechanical systems with distributed parameters as discrete systems made of elements with lumped parameters such as springs, mass, dampers. As regards the frequency characteristics, these discrete systems are complete analogue to the original system. For electromechanical systems, a discrete representation in the form of equivalent electric circuit made of electric elements with lumped parameters such as resistance, inductance and capacitance can be built in the same way.

An approach for building an electric analogue for electroelastic systems shunted with external electric circuits was proposed earlier in [2]. This approach made it possible to obtain and further analyze the spectrum of natural vibration frequencies of the origin electromechanical system. The main assumption made within the proposed approach was that the original system has no mechanisms of energy dissipation related to mechanical losses.

This paper is devoted to the development of an electric analogue of electromechanical systems containing viscoelastic elements, in which energy dissipation occurs. An electric analogue is modeled as an equivalent electric circuit that contains resistive elements describing energy losses. This circuit allows us to obtain dynamic properties of the original electro-viscoelastic system that are complex natural vibration frequencies. Special emphasis is placed on the calculation of parameters of the elements comprising the electric circuit.

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## References

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[2] Matveenko, V., Iurlov, M., Oshmarin, D., Sevodina, N., and Iurlova, N., “Modelling of vibrational processes in systems with piezoelements and external electric circuits on the basis of their electrical analogue”, *Journal of Intelligent Material Systems and Structures*, Vol. **29** (16), pp. 3254–3265, (2018).