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All published papers received a positive opinion of the members of the Scientific Committees.

Prospective insight

The jubilee of the conference, similarly as the jubilee of every important event in our lives, invites us to reflect on the past and the future.

It was April 1960 when prof. Edmund Karaśkiewicz as a chairman of the Poznan Department of the Polish Society of Theoretical and Applied Mechanics (PTMTS) organized and headed the first two-day symposium on linear and nonlinear vibrations. It took place in Poznan. The symposium became an event organized every two years. The chairmen of the conference changed, but all of them set themselves the goal of caring for high scientific level of the symposium. It resulted in obtaining by the conference a high reputation in the Polish scientific world.

More than 60 years have passed. At that time, we observed the rapid development of technology, which fundamentally affected the world, the life of societies and every single person. The development of new technologies was possible thanks to science. On the other hand, we see how much we can support the development of science through the use of modern technical solutions. Faced with the task of organizing the 30th edition of the VIBSYS conference, we asked ourselves a number of questions. First of all, which research topics are currently the most relevant and important from the scientific and application point of view. The second issue was to define an attractive way to exchange knowledge, popularize science and encourage young scientists to conduct research.

We decided to answer the first of these questions together with the conference participants who represent various modern trends in the broadly understood subject of vibrations in physical systems. The current and subsequent editions of VIBSYS will allow us to decide which of the topics are particularly worth considering during the conference. In terms of organization, we plan to maintain new ideas that turned out to be right during the conference in 2020. These include a hybrid form of participation both stationary face-to-face on the spot and remote via an online platform, a competition for young scientists on the best presentation of the research results, popularization of history and art through trips to interesting places in the Greater Poland region and the emission of short films encouraging to see, e.g., the exhibition of the National Museum in Poznan during breaks in the sessions.

The special moment during the 30 edition of VIBSYS will be a session dedicated to the memory of prof. Czesław Cempel. Prof. Cempel worked in the Institute of Applied Mechanics and organized the VIBSYS conference many times. He was a chairman and honorary member of the scientific committee. Employees of our Institute, co-authors and friends will present the profile of the professor and his scientific achievements.

At the end of this introduction, we wish the participants fruitful discussions and many pleasant moments during the VIBSYS conference at the Poznan University of Technology.

Chairs of the Conference

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ENERGY HARVESTING USING A PIEZOELECTRIC TRANSDUCER ON EXTERNALLY FORCED BUT DAMPED OSCILLATOR

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ABSTRACT
We are focused on the investigation of the motion of a novel 3-DOF system composed of two parts. The first part contains a linear damped oscillator moving horizontally without any friction. The oscillator is connected to a piezoelectric device for the purpose of energy harvesting. The second part consists of a nonlinear damped pendulum system which is hung up at the center of the system. The dynamical model is excited by harmonic external forces. The Lagrange equations are employed to construct the governing equations, and the multiple scales technique is utilized to evaluate the analytical solutions. The analysis of the resonance scenarios and the solvability constraints yields the modulation equations. The time series of generalized coordinates of the system are analyzed. The dynamical model serves as the source of vibrations for operating the piezoelectric device in order to convert these vibrations to electrical energy. Graphical representations are used to show the effects of excitation amplitude, coupling coefficient, capacitance, load resistance, natural frequency, and damping coefficient versus the output voltage and power. The resonance shapes constructed to explore the steady-state solutions and stability analyses is carried out.

1. INTRODUCTION

Non-renewable fossil fuels are the main energy-producing resources, but they are quickly depleting and will run out within the next several decades. Energy harvesting, which captures unused ambient energy and converts it into a more useful form of energy, is the most promising renewable energy source and a perfect alternative source for energy instead of traditional sources. A piezoelectric device [1, 2] is one of the energy-harvesting devices used to transform mechanical vibrations into electrical power. In this paper, we have developed a novel physical model for energy harvesting.

2. RESULTS AND DISCUSSION

The vibrational analysis covers the system composed of the piezoelectric transducer and vibrational 3DOF mechanical system. The equations of motion are solved analytically [3], and compared with the numerical ones for more consistency and reliability (see Fig. 1). The influence of the coupling between the mechanical model and the piezoelectric device on the electrical production is represented graphically in (Fig. 2). The following non-dimensional governing equations of the model are obtained using Lagrange equations

$$
\begin{aligned}
&\ddot{x} + \beta\,\ddot{z}\sin\theta + \beta\,(1+z)\ddot{\theta}\cos\theta + 2\,\beta\,\dot{z}\,\dot{\theta}\,\cos\theta - \beta\,(1+z)\dot{\theta}^2\sin\theta + c_1\dot{x} + x + \mu\,v + \omega^2 \\
&\qquad = f_1\cos p_1\tau, \\
&\ddot{z} + \ddot{x}\sin\theta - (1+z)\dot{\theta}^2 + c_2\dot{z} + \varpi^2\,z + 3\,\eta^2\alpha\,z + 3\,\eta\,\alpha\,z^2 + \alpha\,z^3 + \omega^2(1+\cos\theta) \\
&\qquad = f_2\cos p_2\tau, \\
&(1+z)^2\,\ddot{\theta} + (1+z)\,\ddot{x}\cos\theta + 2(1+z)\,\dot{z}\,\dot{\theta} + c_3\dot{\theta} + \omega^2(1+z)\sin\theta = f_3\cos p_3\tau, \\
&\dot{v} + \frac{v}{c_p\,R_L\,\omega_1} = \frac{l\,\gamma}{c_p}\dot{x}.
\end{aligned}
\tag{1}
$$

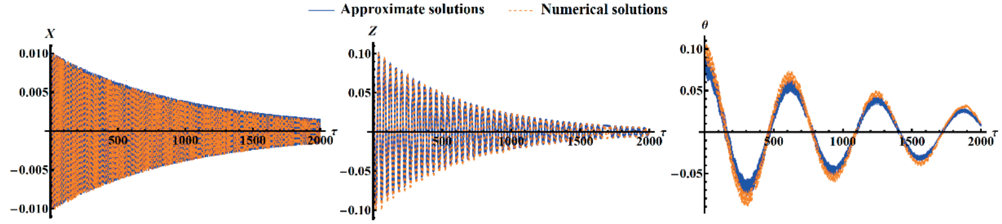

Fig. 1. Time histories of the solutions of Eqs (1).

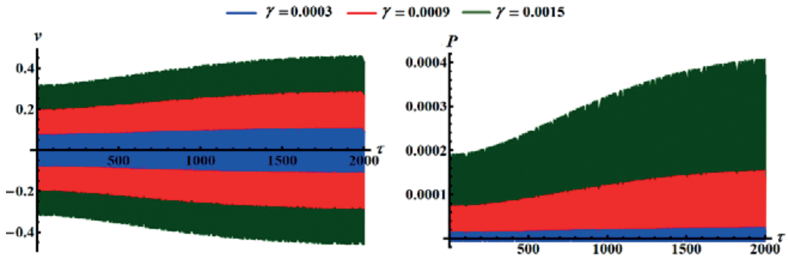

Fig. 2. The effect of different values of the coupling coefficient γ on the output voltage and power of the piezoelectric transducer.

3. CONCLUSION

A novel physical dynamical system connected with a piezoelectric harvesting transducer is investigated. Energy-harvesting technologies have a wide range of uses in daily life such as environmental monitoring, and remote medical diagnosis. The equations of motion are derived and the multiple scale technique is used to obtain the analytical solution. A comparison between the numerical and approximate solutions is represented graphically. The external resonance case is illustrated and then we get the modulation equations. The influence of the effective different parameters of the model on the output voltage and power is examined. Furthermore, resonance response curves are constructed, and then their stability has been investigated.

Acknowledgments

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