

**ABSTRACTS**
**Władysław Egner, Piotr Sulich, Stanisław Mroziński, Halina Egner**
*Temperature Dependent Fatigue Characteristics of P91 Steel*

In this paper, the experimental investigations, constitutive description and numerical modelling of low-cycle fatigue behaviour of P91 steel in non-isothermal conditions are presented. First, experimental tests are performed to recognise different aspects of material behaviour. Then, an appropriate constitutive model is developed within the framework of thermodynamics of irreversible processes with internal state variables. The model describes two phases of cyclic softening, related to plastic mechanisms. An important goal of the presented research is to include thermomechanical coupling in the constitutive modelling. Next, the model parameters are identified based on the available experimental data. Some parametric studies are presented. Finally, numerical simulations are performed, which indicate the significant influence of thermomechanical coupling on the response of the constitutive model in thermomechanical fatigue conditions.

**Heorhiy Sulym, Olena Mikulich, Vasyl' Shvabyuk**
*Modelling of Impulse Load Influence on Stress State of Foam Materials with Positive and Negative Poisson's Ratio*

The influence of impulse load applied for different duration on the distribution of normalised dynamic radial stresses in positive and negative Poisson's ratio medium was investigated in this study. For solving the non-stationary problem in the case of plane deformation for structurally inhomogeneous materials, the model of Cosserat continuum was applied. This model enables accounting for the influence of shear-rotation deformation of micro-particles of the medium. In the framework of Cosserat elasticity, on applying the Fourier transforms for time variable and developing the boundary integral equation method, solving of the non-stationary problem reduces to the system of singular integral equations, where the components that determine the influence of shear-rotation deformations are selected. The numerical calculations were performed for the foam medium with positive and negative Poisson's ratio for different values of time duration of impulse. Developed approach can be used to predict the mechanical behaviour of foam auxetic materials obtained at different values of a volumetric compression ratio under the action of time variable load based on analysis of the distribution of radial stresses in foam medium.

**Krzysztof Wałęsa, Ireneusz Malujda, Dominik Wilczyński**
*Process Analysis of the Hot Plate Welding of Drive Belts*

Most industrial machines use belt transmission for power transfer. These mechanisms often use the round belts of several millimetres in diameter that are made of thermoplastic elastomers, especially polyurethane. Their production process calls for bonding the material, which is often performed by hot plate butt welding. In order to achieve proper design of an automatic welding machine, the authors analysed the hot plate welding process of round belts. This process consists of five phases. It is necessary to recognize all the physical phenomena that occur during welding, especially those connected with thermomechanical properties of material. This knowledge is necessary to determine the temperature distribution during each step of the process. The paper presents a standard welding cycle together with an explanation of the physical phenomena in each phase. An analysis of these fundamentals will be used to derivate the function of temperature distribution during all process phases. In addition, some assumptions for calculation of temperature distribution and some fundamental physic correlations were presented.

**Krzysztof Popławski, Leszek Ambroziak, Mirosław Kondratiuk**
*Electro Pneumatic Control System for Inverted Pendulum*

The paper concerns the inverted pendulum control system with using pneumatic cylinder. A mathematical model of the pendulum used to derive the LQG controller was presented. Prepared laboratory stand was presented and described in detail. The main purpose of the work was experimental researches. A number of control process tests were conducted with variable model parameters such as additional mass, injected disturbances and so on. The results were shown on the time plots of the control object states.

**Houssein Laidoudi**
*Natural Convection from Four Circular Cylinders in Across Arrangement within Horizontal Annular Space*

Numerical investigation is accomplished to study the roles of governing parameters of natural convection on the fluid motion and heat transfer rate of four heated circular cylinders placed inside a circular enclosure of cold surface. The cylinders are positioned in across arrangement. The representative results are obtained within the ranges of initial conditions as: Prandtl number ( $Pr = 7.1$  to  $1000$ ) and Rayleigh number ( $Ra = 103$  to  $105$ ). The average Nusselt number of each inner cylinder is computed. The effects of thermal buoyancy strength on the fluid motion and temperature are also illustrated. It was found that the heat transfer rate of cylinders depends significantly on the position inside the enclosure. Moreover, the role of Prandtl number on flow and thermal patterns is negligible. The values of Nusselt number are also given, which can be useful for some engineering applications.

**Katarzyna Topczewska, Przemysław Zamojski***Effect of Pressure Fluctuations on the Temperature During Braking*

The aim of this study is to develop the numerical–analytical model of frictional heating in a pad/disc system during braking including the pressure fluctuations, engendered by the pump in an anti-skid braking operation. For this purpose, the problem of motion and the one-dimensional thermal problem of friction for a semi-space/semi-space tribosystem were formulated and solved. Obtained solutions allow to calculate temperature distribution on the contact surface and inside the friction elements. Thermal analysis was performed for a metal–ceramic pad and a cast iron disc during one-time braking including the time-dependent, oscillating pressure. The influence of amplitude of pressure fluctuations on the temperature variations was investigated, especially on the value of maximum temperature achieved during braking.

**Ewa Pawłuszewicz***Fractional Vector-Order  $h$ -Realisation of the Impulse Response Function*

The problem of realisation of linear control systems with the  $h$ -difference of Caputo-, Riemann–Liouville- and Grünwald–Letnikov-type fractional vector-order operators is studied. The problem of existing minimal realisation is discussed.

**Oleksiy Bondar***Predictive Neural Network in Multipurpose Self-Tuning Controller*

A very important problem in designing of controlling systems is to choose the right type of architecture of controller. And it is always a compromise between accuracy, difficulty in setting up, technical complexity and cost, expandability, flexibility and so on. In this paper, multipurpose adaptive controller with implementation of artificial neural network is offered as an answer to a wide range of tasks related to regulation. The effectiveness of the approach is demonstrated by the example of an adaptive thermostat. It also compares its capabilities with those of classic PID controller. The core of this approach is the use of an artificial neural network capable of predicting the behaviour of controlled object within its known range of parameters. Since such a network, being trained, is a model of a regulated system with arbitrary precision, it can be analysed to make optimal management decisions at the moment or in a number of steps. Network learning algorithm is backpropagation and its modified version is used to analyse an already trained network in order to find the optimal solution for the regulator. Software implementation, such as graphical user interface, routines related to neural network and many other, is done using Java programming language and Processing open-source integrated development environment.