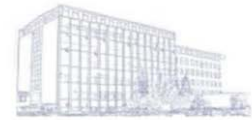# MASING 2020

THE FIFTH INTERNATIONAL CONFERENCE "MECHANICAL ENGINEERING IN XXI CENTURY"

Book of Abstracts
&
Conference
Programme

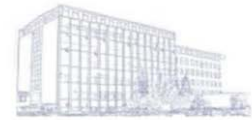**December 09-10, 2020**
Niš, Serbia

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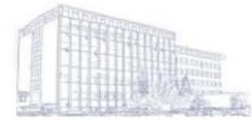
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CONFERENCE PROGRAMME OVERVIEW

Wednesday, December 9th, 2020

Time (CET)	Activities
10^00 – 11^45	**MASING 2020 opening – MS Teams - link** *Welcome speech:* - **Prof. dr Nenad T. Pavlović,** Dean of the Faculty of Mechanical Engineering in Niš - **Prof. dr Predrag Janković,** President of Organizing Committee **Plenary Session** **Zoran MILJKOVIĆ, Milica PETROVIĆ** *A Survey of Swarm Intelligence-based Optimization Algorithms for Tuning of Cascade Control Systems: Concepts, Models and Applications* **Srđan BOŠNJAK, Nebojša GNJATOVIĆ** *Bucket Wheel Excavators: Balancing and Dynamic Response of the Slewing Superstructure* **Rado MAKSIMOVIĆ** *Access to Measuring and Balancing of Enterprise's Key Performance Indicators* **Alpar LOŠONC** *Engineering Ethics in the Pandemic*
12^00 – 14^30	**Paper sections – session 1**

Thursday, December 10th, 2020

10^00 – 12^30	**Paper sections – session 2**

CONFERENCE SECTIONS

	Wednesday, December 9th, 2020, 12^00 – 14^30	
Session 1	A.	Mechanical design, development and engineering, part 1
	B.	Mechatronics and control
	C.	Challenges of the engineering profession in modern industry
	D.	Engineering management
	E.	Theoretical and applied mechanics and mathematics
	Thursday, December 10th, 2020, 10^00 – 12^30	
Session 2	F.	Energetics, energetic efficiency and process engineering, part 1
	G.	Energetics, energetic efficiency and process engineering, part 2
	H.	Mechanical design, development and engineering, part 2
	I.	Production and information technologies
	J.	Traffic engineering, transport and logistic

Plenary Session – Abstracts

A Survey of Swarm Intelligence-based Optimization Algorithms for Tuning of Cascade Control Systems: Concepts, Models and Applications

Zoran MILJKOVIĆ, Milica PETROVIĆ

University of Belgrade, Faculty of Mechanical Engineering, Department of Production Engineering, 11120 Belgrade

Abstact. Nowadays, cascade control is still one of the most used control strategies in the manufacturing and process industries. The new requirements of precision and robustness of position and trajectory tracking in control systems for manufacturing components at micro-scale, influenced by hard nonlinearities such as friction and backlash, have motivated the effort toward the development of algorithms for optimal tuning of control parameters. This paper presents a literature review of the algorithms and methods used to solve this problem. Swarm intelligence inspired optimization algorithms, namely particle swarm optimization algorithm (PSO) and grey wolf optimization algorithm (GWO), are applied for tuning of P-PI cascade controllers of CNC machine tool servo system in the presence of friction and backlash. The objective of the optimization is to minimize the maximum position error during the reversal of the axes. A comparative analysis of proposed algorithms with a standard industry-based fine tune (FT) method is also provided. Simulation study as well as real-world experiments carried out on a CNC machine tool controller show a remarkable improvement in the performance of the cascade control system using the proposed swarm intelligence-based strategy.

Bucket Wheel Excavators: Balancing and Dynamic Response of the Slewing Superstructure

Srđan BOŠNJAK, Nebojša GNJATOVIĆ

First Author affiliation: University of Belgrade-Faculty of Mechanical Engineering, Kraljice Marije 16, Belgrade, Serbia
Second Author affiliation: University of Belgrade-Faculty of Mechanical Engineering, Kraljice Marije 16, Belgrade, Serbia

Abstract. A slewing superstructure (SS) represents a key functional subsystem of bucket wheel excavators (BWEs). Identification of its basic parameters of static stability (BPSS: weight and position of the center of gravity) is of equally crucial significance in design of a BWE and in its exploitation. The BPSS dominantly determine the static stability of a BWE SS and, coupled with stiffness, its dynamic response. This paper presents the results of research on the impact of the difference between the experimentally and analytically determined SS BPSS on the: (1) intensities of forces in the ropes of the bucket wheel boom hoisting mechanism; (2) maximum loads of the SS radiaxial slew bearing balls; (3) dynamic response of the SS. The presented research represents the initial stage in forming of the integral methodology for the assessment of impact of the mentioned differences on the key indicators which determine the lifespan and integrity, as well as reliability and safety of the SS of BWEs and related surface mining and material handling machines.
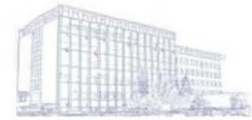
Access to Measuring and Balancing of Enterprise's Key Performance Indicators

Rado MAKSIMOVIC

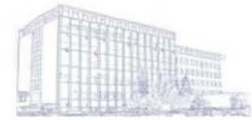*University of Novi Sad, Faculty of Technical Sciences*

Abstract. Measuring performances business processes nowadays, has become routine practice in enterprises that have adopted quality management system according to ISO 9001 standard requests, since that is one of key requests of that standard. On the other hand, in a recent scientific literature the term "Key Performance Indicators (KPIs)" is introduced, primarily as a tool for enterprise's market performance analysis. However, reviewing the mentioned literature as well as insight in practical use in the enterprises have shown that measuring and analyzing enterprise's performances doesn't have systematic approach, and that there is a large number of different models in use. Rarely, one can find business field where Key Performance Indicators model has been brought to the level of standardization. This paper is about establishing comprehensive, systematic model of enterprise's performances identification and their measuring methods through appropriate key indicators, according to the existing models, a step forward was made in terms of suggesting the way of reaching satisfying level of performances balance, by putting them into Balanced Scorecard. The method of constant monitoring over the performances is implied (over their indicators), as well as the case study.

Engineering Ethics in the Pandemic

Alpar LOŠONC

Faculty of Technical Sciences, University of Novi Sad, Trg Dositeja Obradovića 6, 21000 Novi Sad, Serbia

Abstract. How to treat the exceptional importance of engineering ethics that is reflected in multiple forms of certain engagement? This paper is divided into three parts. The first part focuses on the explanation of why ethical reflection has penetrated deeply into engineering. The second part focuses on the analysis of certain moments during the pandemic, that is, the problematization of coevolution of technology, society, and nature. In the third, the final part, the focus is on three serious ethical dilemmas facing engineering ethics.

	Section A - Mechanical design, development and engineering, part 1 (*please access this link*) Section chairs: Boban Anđelković, Aleksandar Miltenović
1	**Tanasije JOJIĆ, Jovan VLADIĆ, Radomir ĐOKIĆ** *Zipline Design Issues and Analysis of the Influencing Parameters on Passenger's Velocity*
2	**Marko MLADENOVIĆ, Natalija TOMIĆ, Boban ANĐELKOVIĆ, Miloš MILOŠEVIĆ** *Current State of Fused Deposition Modelling 3D Printer Systems*
3	**Natalija B. TOMIĆ, Marko V. MLADENOVIĆ, Boban R. ANĐELKOVIĆ, Aleksandar G. STANKOVIĆ, Milan Z. GROZDANOVIĆ** *Selection of Fused Deposition Modeling 3D Printer using Multi-Criteria Decision-Making Method*
4	**Sulaiman E. Al-basaqr, Amir Alsammarraie, Abed Fares Ali** *Investigating Fatigue Life of E-glass fiber/Novolac/epoxy (DGEBA) hybrid Composites*
5	**Goran PAVLOVIĆ, Mile SAVKOVIĆ, Nebojša ZDRAVKOVIĆ and Goran MARKOVIĆ** *Optimal Design for the Welded Girder of the Crane Runway Beam*
6	**Miodrag ARSIĆ, Srđan BOŠNJAK, Vencislav GRABULOV, Mladen MLADENOVIĆ, Zoran SAVIĆ** *Sanation of the Synchronous Valve Casing of Hydroelectric Generating Set on Hydro Power Plant Pirot*
7	**Dušan ĆIRIĆ, Jelena MIHAJLOVIĆ and Miroslav MIJAJLOVIĆ** *Transient Finite Element Analysis (FEA) in Material Selection Process: Introduction*

Section A – Abstracts

A1. Zipline Design Issues and Analysis of the Influencing Parameters on Passenger's Velocity
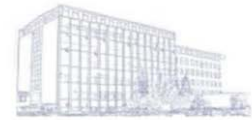
Tanasije JOJIĆ, Jovan VLADIĆ, Radomir ĐOKIĆ

First Author affiliation: Faculty of Technical Sciences, Trg Dositeja Obradovića 6, Novi Sad, Serbia
Second Author affiliation: Faculty of Technical Sciences, Trg Dositeja Obradovića 6, Novi Sad, Serbia
Third Author affiliation: Faculty of Technical Sciences, Trg Dositeja Obradovića 6, Novi Sad, Serbia

Abstract. The paper explains the issues of zipline designing and provides an analysis of the influencing parameters, relevant model forming, and the procedure for determining kinematic quantities of a passenger traveling along a zipline. The theoretical background consists of two parts, i.e. the first one, which includes static analysis based on catenary theory, and the second, which takes into account inertial forces, movement resistance, air resistance, wind effect, the position of a passenger during lowering, anchoring type, tightening force, etc, on the base of which it is possible to determine all necessary kinematic quantities which are essential for defining the so-called "driving characteristic" of zipline. The analysis are made by computer simulations where the size of significant parameters can be varied. Analysis results are given through diagrams that show a passenger's position, velocity, or acceleration in relation to time or a traveled distance for different lowering positions of the passenger.

A2. Current State of Fused Deposition Modelling 3D Printer Systems

Marko MLADENOVIĆ[1], Natalija TOMIĆ[2], Boban ANĐELKOVIĆ[2], Miloš MILOŠEVIĆ[2]

[1] *Faculty of Mechanical Engineering, University of Niš; Research and development, Harder Digital Sova, Niš, 18000*

[2] *Faculty of Mechanical Engineering, University of Niš*

Abstract. Since their appearance in 1992. Fused Deposition Modelling (FDM) 3D printers have shown the potential to become one of the most economical additive manufacturing techniques. Fused Deposition Modelling (FDM) started to rapidly develop by the expiration of the FDM patent and the subsequent worldwide development of low cost FDM machines by a huge number of small companies. Today, there is a large range of these machines in development and on the market with different printing mechanics. The purpose of this paper is to present different types of FDM machines based on their kinematics as well as pros and cons of different design types of FDM machines and their elements. This paper also present different advanced features designed to suit specific purpose, solve specific problems or improve on other designs.

A3. Selection of Fused Deposition Modeling 3D Printer using Multi-Criteria Decision-Making Method

Natalija B. TOMIĆ, Marko V. MLADENOVIĆ, Boban R. ANĐELKOVIĆ, Aleksandar G. STANKOVIĆ, Milan Z. GROZDANOVIĆ

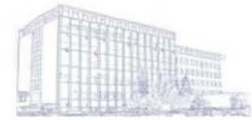*Natalija B. Tomić: Faculty of Mechanical Engineering, University of Niš*
Marko V. Mladenović: Faculty of Mechanical Engineering, University of Niš;
Research and development, Harder Digital Sova, Niš, 18000
Boban R. Anđelković: Faculty of Mechanical Engineering, University of Niš
Aleksandar G. Stanković: Faculty of Mechanical Engineering, University of Niš
Milan Z. Grozdanović: Faculty of Mechanical Engineering, University of Niš

Abstract. With the increasing development of the industry, additive technologies have found application in various fields around the world. Creating unique items has never been easier, even at home. Such a rapid development of additive technologies is due to the expiration of the fused deposition modeling (FDM) patent and the development of cheap electronic components needed to control these devices. Such rapid development has brought to the market a large number of devices of different manufacturers, formats and constructions. The existence of a large number of different devices requires the new user to know the advantages and disadvantages of different constructions, kinematics and generally different types of FDM machines. The paper deals with multi-criteria decision-making (MCDM) of FDM printers, where their main criteria will be their economic and technical characteristics. The aim of this paper is to find the most optimal 3D printer according to the selected criteria.

A4. Investigating Fatigue Life of E-glass Fiber/Novolac/Epoxy (DGEBA) Hybrid Composites

Sulaiman Al-basaqr, Amir Alsammarraie, Abed Fares Ali

University of Tikrit/ Engineering College/ Mechanical Engineering Dep. Tikrit, Iraq

Abstract. The fatigue considers the type of the failure types for the geometric parts because it suffers from dynamic and fluctuating stress as in the aircraft, the ships, the bridges, and other geometric parts. The fatigue of composite materials is not fully understood which is perfectly different from metal fatigue. In the present study the prepared hybrid composite materials specimen reinforcement E-Glass fiber for 10%,20%, and 30% volume fraction that have two preparation of matrix (80% EP, 60% NO) and (40% EP, 20% NO). has been applied to fatigue loading in-plane bending with R = ±1 and S-N. curves are plotted. the laboratory tests and the results show decreasing in the number of fatigue cycles even failure when the applied load on the specimens increases. The fracture will be brittle because there are adding Novolac materials to obtain hard hybrid composites specimens.
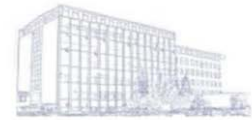
A5. Optimal Design for the Welded Girder of the Crane Runway Beam

Goran PAVLOVIĆ[1], Mile SAVKOVIĆ[2], Nebojša ZDRAVKOVIĆ[2] and Goran MARKOVIĆ[2]

[1] *University of Niš, Faculty of Electronic Engineering, Serbia*

[2] *University of Kragujevac, Faculty of Mechanical and Civil Engineering in Kraljevo, Serbia*

Abstract. Nowadays, cascade control is still one of the most used control strategies in the manufacturing and process industries. The new requirements of precision and robustness of position and trajectory tracking in control systems for manufacturing components at micro-scale, influenced by hard nonlinearities such as friction and backlash, have motivated the effort toward the development of algorithms for optimal tuning of control parameters. This paper presents a literature review of the algorithms and methods used to solve this problem. Swarm intelligence inspired optimization algorithms, namely particle swarm optimization algorithm (PSO) and grey wolf optimization algorithm (GWO), are applied for tuning of P-PI cascade controllers of CNC machine tool servo system in the presence of friction and backlash. The objective of the optimization is to minimize the maximum position error during the reversal of the axes. A comparative analysis of proposed algorithms with a standard industry-based fine tune (FT) method is also provided. Simulation study as well as real-world experiments carried out on a CNC machine tool controller show a remarkable improvement in the performance of the cascade control system using the proposed swarm intelligence-based strategy.

A6. Sanation of the Synchronous Valve Casing of Hydroelectric Generating Set on Hydro Power Plant Pirot

Miodrag ARSIĆ[1], Srđan BOŠNJAK[2], Vencislav GRABULOV[1], Mladen MLADENOVIĆ[1], Zoran SAVIĆ[1]

[1] Institute for Materials Testing, Bulevar vojvode Mišića 43, Belgrade, Serbia

[2] Faculty of Mechanical Engineering, Kraljice Marije 16, Belgrade, Serbia

Abstract. Corrosion, erosion and cavitation have a significant influence on parts of turbine and hydromechanical equipment in exploitation. The same can be said when it comes to damaging of surfaces of the synchronous valve which is a part of the vertical Francis turbine runner of the hydroelectric generating set A1 at HPP ''Pirot'', with nominal power of 40 MW. Erosion of surfaces of hydraulic machine components exposed to the effect of cavitation can become a large scale problem in a short while, while depths of cavities can reach up to 100 mm. This paper contains the technology of sanation of damages through repair welding, tests performed after sanation, as well as suggestions for execution of optimal anticorrosion protection that refer to the synchronous valve of the hydroelectric generating set A1 at HPP 'Pirot'.
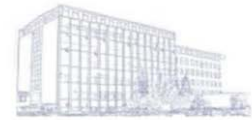
A7. Transient Finite Element Analysis (FEA) in Material Selection Process: Introduction

Dušan ĆIRIĆ[1], Jelena MIHAJLOVIĆ[1] and Miroslav MIJAJLOVIĆ[2]

[1] PhD Student: University of Niš, Faculty of Mechanical Engineering, Aleksandra Medvedeva 14, Niš, Serbia

[2] Associate Professor: University of Niš, Faculty of Mechanical Engineering, Aleksandra Medvedeva 14, Niš, Serbia

Abstract. Nowadays, cascade control is still one of the most used control strategies in the manufacturing and process industries. The new requirements of precision and robustness of position and trajectory tracking in control systems for manufacturing components at micro-scale, influenced by hard nonlinearities such as friction and backlash, have motivated the effort toward the development of algorithms for optimal tuning of control parameters. This paper presents a literature review of the algorithms and methods used to solve this problem. Swarm intelligence inspired optimization algorithms, namely particle swarm optimization algorithm (PSO) and grey wolf optimization algorithm (GWO), are applied for tuning of P-PI cascade controllers of CNC machine tool servo system in the presence of friction and backlash. The objective of the optimization is to minimize the maximum position error during the reversal of the axes. A comparative analysis of proposed algorithms with a standard industry-based fine tune (FT) method is also provided. Simulation study as well as real-world experiments carried out on a CNC machine tool controller show a remarkable improvement in the performance of the cascade control system using the proposed swarm intelligence-based strategy.

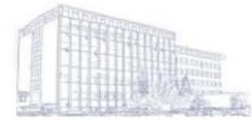|	**Section B - Mechatronics and control** (*please access this link*) Section chairs: Miloš Milošević, Miloš Simonović
1	**Stevan STANKOVSKI, Dragan KUKOLJ, Gordana OSTOJIĆ, Igor BARANOVSKI, Sandra NEMET** *Trends in Artificial Intelligence for Automated Industrial Systems*
2	**Lara LABAN, Mitra VESOVIĆ** *Classification of COVID-CT Images Utilizing Four Types of Deep Convolutional Neural Networks*
3	**Mitra VESOVIĆ, Radiša JOVANOVIĆ, Vladmir ZARIĆ** *Modelling and Speed Control in a Series Direct Current (DC) Machines Using Feedback Linearization Approach*
4	**Vladimir ZARIĆ, Radiša JOVANOVIĆ, Lara LABAN** *Identification of a Coupled-Tank Plant and Takagi-Sugeno Model Optimization Using a Whale Optimizer*
5	**Dušan STOJILJKOVIĆ, Nenad T. PAVLOVIĆ** *Influence of Flexure Hinges Design on Guiding Accuracy of Roberts-Чебышев Compliant Mechanism*
6	**Andrija MILOJEVIĆ, Kenn OLDHAM** *Design of a New Micro-robotic Appendages Comprised of Active Thin-film Piezoelectric Material*
7	**Andrija MILOJEVIĆ, Kyrre GLETTE** *Design Optimization of Terrestrial-Walking Soft Robots*
8	**Sava RAMANOVIĆ, Nenad PAVLOVIĆ, Miloš STOJKOVIĆ, Žarko ĆOJBAŠIĆ** *Smart Mitkovic External Fixation System for Bones*

Section B – Abstracts

B1. Trends in Artificial Intelligence for Automated Industrial Systems

Stevan STANKOVSKI[1], Dragan KUKOLJ[1], Gordana OSTOJIĆ[1], Igor BARANOVSKI[1], Sandra NEMET[2]

[1] *Faculty of Technical Sciences, University of Novi Sad, Novi Sad, 21000, Serbia*

[2] *RT-RK Institute for Computer Based Systems, Novi Sad, Serbia*

Abstract. The influence of Artificial Intelligence (AI) is spreading up rapidly in many areas of automated industrial systems. As automated industrial systems are becoming more complex, the demand for production without faults is growing and it starts to be a huge issue to solve complex problems with limited human resources and knowledge and within a limited time. The right solution is adopting AI in the process of making decisions in these problems. The potential of AI is growing in different aspects of manufacturing management and control of automated industrial systems. Edge computing on PLC gives the opportunity to put in practice the potential of AI, especially in fault prediction. In this paper are given recent trends in artificial intelligence for automated industrial systems.

B2. Classification of COVID-CT Images Utilizing Four Types of Deep Convolutional Neural Networks

Lara LABAN, Mitra VESOVIĆ

Control Engineering, Faculty of Mechanical Engineering, Kraljice Marije 16, Belgrade, Serbia

Abstract. In this paper a method is presented for the classification of COVID-CT (CT_COVID, CT_NonCOVID) image data set. Four different types of deep convolutional neural networks are proposed, two with the architecture resembling the VGGNet, one resembling the LeNet-5 and one using transfer learning. In addition, neural networks utilized the following techniques: decay, dropout and batch normalization. Since we needed to combat a significantly small dataset, we used data augmentation in order to transform and expand our dataset. Moreover, juxtapositions were made when observing the results given by these four neural networks, as well as the affect made by two different optimizers. The training of the neural networks was done using small batches with a binary cross entropy loss function, in order to achieve an up to scratch classification accuracy.

B3. Modelling and Speed Control in a Series Direct Current (DC) Machines Using Feedback Linearization Approach

Mitra VESOVIĆ, Radiša JOVANOVIĆ, Vladmir ZARIĆ

Faculty of Mechanical Engineering, University of Belgrade, Kraljice Marije 16, 11120 Belgrade, Serbia
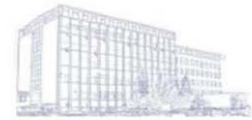
Abstract. In this paper the nonlinear feedback control system is presented for the speed control in direct current - DC motor. Nonlinear functions of dead zone, Coulomb and viscous friction were investigated and used for obtaining the mathematical model. The effectiveness and the comparison between linear and nonlinear control signal have been confirmed using Matlab/Simulink software. From the conclusions, based on the experimental results, it is easy to see that nonlinear control system is more acceptable and has a better performance for speed control. The validity of using feedback linearization in DC motors has been proven.

B4. Identification of a Coupled-Tank Plant and Takagi-Sugeno Model Optimization Using a Whale Optimizer

Vladimir ZARIĆ, Radiša JOVANOVIĆ, Lara LABAN

Control Engineering, Faculty of Mechanical Engineering, Belgrade,Serbia

Abstract. The process industries have continually combated the problem concerning liquid level control. Effective control of a system depends largely on the accuracy of the mathematical model that predicts its dynamic behavior. In this paper the Takagi-Sugeno fuzzy model for the coupled-tank system was acquired based on empirical technique. Furthermore, a metaheuristic algorithm was used as an optimizer on the coupled-tank model. Then, a juxtaposition was made when comparing models which were identified and optimized, leading to satisfactory results. Experimental results obtained on the coupled-tank system are provided.

B5. Influence of Flexure Hinges Design on Guiding Accuracy of Roberts - Чебышев Compliant Mechanism

Dušan STOJILJKOVIĆ, Nenad T. PAVLOVIĆ

Department of Mechatronics and Control, Faculty of Mechanical Engineering, University of Niš, Aleksandra Medvedeva 14, Niš, Serbia

Abstract. Compliant mechanisms gain some or all of their mobility from the compliance of their joints rather than from rigid-body joints only. They can be built in one piece and represent material coherent structure being able to transfer the forces and transform the motion due to energy stored in compliant joints - flexure hinges. The investigations in the paper present the potential of improving the accuracy of the coupler point rectilinear path of the Roberts-Чебышев four-bar linkage. This is done by developing the Roberts-Чебышев compliant mechanism and by applying the new specific design of the flexure hinge. Hence, it will be described that the position of this flexure hinges and their geometry are of a vital issue for performing approximately rectilinear path. Therefore, several designs are investigated by means of finite elements method (FEM) simulation.
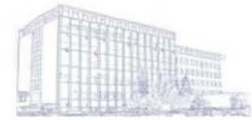
B6. Design of a New Micro-robotic Appendages Comprised of Active Thin-film Piezoelectric Material

Andrija MILOJEVIĆ[1], Kenn OLDHAM

[1] *Laboratory of Intelligent Machines, Department of Mechanical Engineering, School of Energy Systems, Lappeenranta University of Technology, Yliopistonkatu 34, 53850 Lappeenranta, Finland*

[2] *Vibration and Acoustics Laboratory: Microsystems, Department of Mechanical Engineering, University of Michigan Ann Arbor, 2380C GGB (George G. Brown Laboratory), 2350 Hayward, Ann Arbor, MI 48109-2125, MI USA*

Abstract. This paper introduces, a novel MEMS terrestrial micro-robot structure, i.e. micro-robotic appendages, realized by utilizing recently developed thin-film piezoelectric actuators (PZT). Thin-film PZT's offer many benefits for the micro-robots, including large out-of-plane motions and fast actuation speeds. A synthesis methodology for micro-robotic appendages comprised fully of the thin-film PZT is presented. The developed method is inspired by structural topology optimization. Different obtained solutions of the robotic appendage designs are shown, and their performance is investigated. The deformation behaviour of the micro-robotic appendages is further verified via finite element method simulations. It is shown how such robotic appendages can realize a different range of output motions when all thin-films PZT is activated. The presented design method could lead to the realization of different MEMS micro-robots.

B7. Design Optimization of Terrestrial-Walking Soft Robots

Andrija MILOJEVIĆ[1], Kyrre GLETTE[2]

[1] *Laboratory of Intelligent Machines, Department of Mechanical Engineering, School of Energy Systems, Lappeenranta University of Technology, Yliopistonkatu 34, 53850 Lappeenranta, Finland*

[2] *RITMO Centre for Interdisciplinary Studies in Rhythm, Time and Motion, Department for Informatics, University of Oslo, P.O box 1080 Blindern 0316 OSLO, Norway*
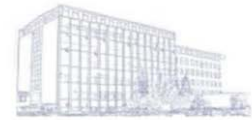
Abstract. Unlike classical rigid body-based robots, soft robots are built from soft materials and they utilize elastic deformation (of its body) to achieve motion and different tasks. This paper introduces a new type of soft terrestrial walking robots realized by using compliant mechanisms. The synthesis approach for the optimal design of terrestrial robots is presented i.e. for one soft robotic leg. The design method is based on a structural optimization approach and using evolutionary algorithms, here expanded to spatial problems and topologies. Two different obtained solutions of the robotic legs are shown, and their performance is investigated. Based on this a concept of full two-leg robots is realized. The deformation behaviour of the designs is further analysed using the nonlinear finite element method. The prototype of one terrestrial two-leg soft robot is shown as well. The presented synthesis method and robot designs can lead to the realization of different types of walking soft robots with advanced locomotion capabilities.

B8. Smart Mitkovic External Fixation System for Bones

Sava RAMANOVIĆ, Nenad PAVLOVIĆ, Miloš STOJKOVIĆ, Žarko ĆOJBAŠIĆ

Faculty of Mechanical Engineering, University of Niš, Ul. Aleksandra Medvedeva 14, 18000 Niš, Srbija

Abstract. The use of external fixators has gained great popularity due to simple application, as well as the successful and fast treatment of bone fractures. In addition to the treatment of fractures, its use has found a place in bone correction surgery, such as in lengthening, angular correction, or reconstruction of long bones. These corrections were made manually until the advent of the computer assistance, which enables monitoring of the parameters of sensor use and positioning of the fracture fragments by means of actuators integrated into the fixator itself. This method of fracture treatment and bone correction led to flexibility of operational procedures, but the problem remained that the control and engagement of surgeons remained frequent. The aim of this research is to introduce the smart features in the external fixation system of Mitkovic type that would move actuators through the data obtained from the sensors and thus make a decision on postoperative treatment of the patient and reduce the engagement of the surgeon.

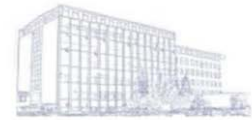|	Section C - Challenges of the engineering profession in modern industry (*please access this link*) Section chairs: Alpar Lošonc, Miloš Tasić
1	**Dušan MOJIĆ, Branka MATIJEVIĆ** *ICT Study Programs in Higher Education in Serbia: Analysis of Main Trends*
2	**Vesna STANKOVIĆ PEJNOVIĆ** *Instrumentalization of Knowledge in Neoliberalism*
3	**Ivana ILIĆ-KRSTIĆ, Vesna MILTOJEVIĆ** *Engineers, Ethics and Professionalism*
4	**Alpar LOŠONC, Andrea IVANIŠEVIĆ** *Bounded Rationality and Engineering Ethics*
5	**Gordana V. STOJIĆ** *The World of Machines and Engineers in Kurt Vonnegut's Negative Utopia*
6	**Miloš TASIĆ, Jelena DINIĆ, Dragoljub B. ĐORĐEVIĆ** *Engineers' Perception of the Importance of English in Their Professional and Academic Careers*
7	**Mahouton Norbert Hounkonnou, Melanija MITROVIĆ** *Mathematics for human flourishing In the time of COVID-19 and post COVID-19*

Section C – Abstracts

C1. ICT Study Programs in Higher Education in Serbia: Analysis of Main Trends

Dušan MOJIĆ[1], Branka MATIJEVIĆ[2]

[1] *Faculty of Philosophy, University of Belgrade, Čika Ljubina 18-20, Belgrade, Serbia*

[2] *Institute of Social Sciences, Kraljice Natalije 45, Belgrade, Serbia*

Abstract. The paper analyzes main trends in development of ICT study programs at higher education institutions (HEIs) in Serbia. Significant increase in number and scope of these programs has been one of the most important characteristics of Serbian higher education sector in the last two decades. Such development has been the result of a complex interplay of global, national and sectorial factors. What all of these factors have in common is the market principle, which has also become one of the corner-stones of the HEIs' development strategies. Such strong environmental pressures has forced HEIs to undergo transformations that will maintain and improve their market positions. The market principle has prompted the proactive behavior of HEIs towards customers/future students. These transformation strategies to a large extent depend on the labor market trends, represented on the level of individual actors/customers by the perception of employment possibilities enabled by a specific degree. The goal of the paper is to provide general insight into the diversity of ICT study programs at HEIs in Serbia, which represents one of the key strategic responses to said market pressures.

C2. Instrumentalization of Knowledge in Neoliberalism

Vesna STANKOVIĆ PEJNOVIĆ

Institute for Political Science, Svetozara Markovića 36, Belgrade

Abstract. Education has been powerfully affected by the rise of a neoliberal political, economic and cultural agenda. Education is social process of nurturing capacities for practice. Recent changes in education can be understood in the general context of transition, where, despite appearances to the contrary, capitalism is in decline and competing with the burgeoning movements of the potential future society.The commodification of services and the privatization of public sector agencies demands institutional and cultural change. The profit-seeking corporation is promoted as the admired model for the public sector, and for much of civil society too. Schemes of organization and control are imported from business to public institutions. But the policy changes all move in the same direction – increasing the grip of market logic on schools, universities and technical education.

C3. Engineers, Ethics and Professionalism

Ivana ILIĆ-KRSTIĆ, Vesna MILTOJEVIĆ

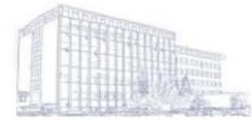*University of Niš, Faculty of Occupational Safety, Niš, Serbia*

Abstract. Sustainable development, a topic exhaustively discussed ever since the Brundtland Report in 1987, provides a broad framework for pro-environmental activities of industrial engineers. This paper is based on the previous findings concerning the negative pressure of engineering activities on the environment and it highlights the necessity of reinterpreting the engineers' roles and activities under the current ecological conditions. The concept of sustainable development provides engineers with a key role in designing and managing "clean technology", i.e. technological systems that are less harmful, more efficient, and socially and environmentally more acceptable. The paper examines to what extent engineers can work and contribute to sustainable development within their professional roles and specifies their roles and responsibilities. Special emphasis is placed upon creativity, ethics, and professionalism in view of the new role of engineers, as well as upon the investigation of the identified ethical and professional dilemmas facing the 21st century engineers. The paper also highlights the changes in industrial systems and the changed roles of engineers in order to determine the new educational needs of the engineers who represent the driving force behind industrial activities for the future.

C4. Bounded Rationality and Engineering Ethics

Alpar LOŠONC, Andrea IVANIŠEVIĆ

Faculty of Technical Sciences, University of Novi Sad, Serbia

Abstract. Bounded rationality and engineering ethics are related since the concept of bounded rationality shapes the conditions for making decisions, which includes the conditions for ethical decisions too. Consequently, this raises the question of nature of the said connection. This paper presents a thesis on indirect connections, in contrast to some thinkers who view bounded rationality as a direct constitutive element of moral reasoning. Engineering ethics is a normative discipline, and the concept of bounded rationality is not normative in its character. Thus, in the light of some interpretations, bounded rationality can be considered as highly valuable for engineering ethics.

C5. The World of Machines and Engineers in Kurt Vonnegut's Negative Utopia

Gordana STOJIĆ

Department of Sociology, Faculty of Philosophy, University of Niš, Serbia

Abstract. The subject of the paper is Vonnegut's negative utopia Player Piano, which describes a society in which machines replace the physical and mental work of people, from production to the deployment of people to jobs. The society is divided into the elite (engineers and directors) and unclassified, pushed out of the sphere of work. People's needs are met, but they are deprived of the feeling that they are useful and needed, which is the basis of self-esteem. By depicting a world in which machines rule people by doing exactly what people created them for, Vonnegut raises issues that are relevant today: the consequences of automation, organization and pursuit of efficiency on labor, freedom, social inequalities, leisure and identity. He points out the responsibilities of engineers regarding the creation of such "better world"

C6. Engineers' Perception of the Importance of English in Their Professional and Academic Careers

Miloš TASIĆ, Jelena DINIĆ, Dragoljub B. ĐORĐEVIĆ

Department of Social Sciences, Faculty of Mechanical Engineering, University of Niš,

Aleksandra Medvedeva 14, 18000 Niš, Serbia

Abstract. As the modern-day lingua franca, English plays a crucial role in all sorts of global communication and correspondence. This is also true of the engineering profession and its current reliance on English as its main vehicle for the exchange of information. Therefore, the adequate knowledge of English poses one of the major challenges in the development of an engineer's professional identity. Bearing this in mind, the paper deals with the engineers' own perception of the importance of English in their professional and academic careers, with a particular emphasis on the potential shortcomings caused by the lack of both oral and written communicative competence and the ways in which such drawbacks could be overcome with the aim of facilitating their further career advancement. The conducted study employs a survey based on a questionnaire used to examine the positive and negative consequences of varying levels of knowledge of English from the viewpoint of engineers. The results obtained through statistical analysis reflect their opinions on the most important aspects of the matter at hand. The paper ends with concluding remarks that contain several recommendations on how the observed issues can be tackled successfully.
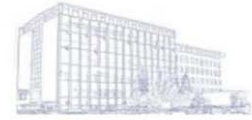
C7. Mathematics for Human Flourishing in the Time of COVID-19 and Post COVID-19

Mahouton NORBERT HOUNKONNOU[1], Melanija MITROVIĆ[1]

[1] *International Chair in Mathematical Physics and Applications, University of Abomey-Calavi, Benin,*

[2] *Department of Mathematics and Informatics, Faculty of Mechanical Engineering Niš, Serbia*

Abstract. The International Chair in Mathematical Physics and Applications (ICMPA-UNESCO chair), University of Abomey-Calavi, Benin, and the Center for Applied Mathematics of the Faculty of Mechanical Engineering Niš, CAM-FMEN, organized a webinar on Mathematics for human flourishing in the time of COVID-19 and post COVID-19, 21 October 2020, supported by the City of Niš. The scientific response to COVID-19 is multi-disciplinary, involving health sciences, social sciences, and fundamental sciences such as mathematics. The objectives of the webinar were to give precise information about the work that scientists do to cure the disease, to push forward technology, to understand our society and create new expressions of humanity, and to question the role of mathematics in the responses to this pandemic.
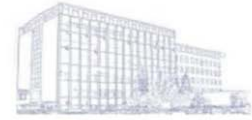
	Section D - Engineering management
	(*please access this link*)
	Section chairs: Peđa Milosavljević, Anđela Lazarević
1	**Biljana PETKOVIĆ, Dalibor PETKOVIĆ, Ivan RADOJKOVIĆ, Miloš MILOVANČEVIĆ** *Determination of the optimal parameters of the wastewater systems based on the largest economic profit*
2	**Dragan PAVLOVIĆ, Peđa MILOSAVLJEVIĆ, Srđan MLADENOVIĆ** *Synergy between Industry 4.0 and Lean Methodology*
3	**Ivana MARINOVIC MATOVIC, Andjela LAZAREVIC** *Covid-19 Crisis Management in Manufacturing Industry Organizations in the Republic of Serbia*
4	**Andjela LAZAREVIC, Ivana MARINOVIC MATOVIC, Srdjan MLADENOVIC** *The Role and Importance of Standards for the Quality of Services in Educational Institutions in the Field of Mechanical Engineering*
5	**Ivan RADOJKOVIĆ, Branislav RANĐELOVIĆ** *A New Risk Management Model for Auto insurance in Serbia*
6	**Dragan TEMELJKOVSKI[1], Marko PAVLOVIC[2], Stojanče NUSEV[3], Dragana TEMELJKOVSKI NOVAKOVIĆ** *Reengineering of Aluminium Melting and Casting Plants in Aluminum Processing Factory*
7	**Zorana KOSTIĆ** *Economic Challenges and Integration Engineering: The Smart Cities Context*
8	**Milena RAJIĆ, Pedja MILOSAVLJEVIĆ, Rado MAKSIMOVIĆ, Dragan PAVLOVIĆ** *Energy Management Model for Sustainable Production Process – A Case Study*
9	**Miroslav FERENČAK, Dušan DOBROMIROV, Mladen RADIŠIĆ** *Personal Income and Aversion to a Sure Loss – Are Money-Makers willing to Risk More to Evade Certain Loss?*

D1. Determination of the Optimal Parameters of the Wastewater Systems Based on the Largest Economic Profit

Biljana PETKOVIĆ [1], Dalibor PETKOVIĆ [2] Ivan RADOJKOVIĆ[3] Milos MILOVANCEVIC[4]
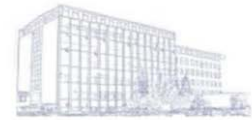*[1]Alfa BK University - Faculty of Finance, Banking and Auditing, Belgrade, Serbia*
[2] University of Niš, Pedagogical Faculty in Vranje, Partizanska 14, 17500 Vranje, Serbia
[3] Dunav Voluntary Pension Fund, Serbia
[4] University of Niš, Faculty of mechanical engineering, A. Medvedeva 14, Nis, Serbia

Abstract. In this article was presented a selection procedure for determination of the most influential parameters of wastewater system for the best economic profit. Optimum wastewater treatment systems require large parameters to be settled in order to achieve optimal solutions. The optimal solutions are often based on the economic profit of the wastewater treatment system. The best economic profit is formulated according the lowest total cost of the wastewater treatment system. By using classical analytical approach for the optimization procedure there is need for time and effort in order to solve the equations since it is very nonlinear system. Therefore in this article the main aim was to determine which parameters of the wastewater treatment system have the largest influence on the economic profit of the system. For the selection purpose adaptive neuro fuzzy inference system (ANFIS) was used since the method is suitable for redundant and nonlinear data. Results revealed that the size of the system has the most influence on the economic profit. Furthermore obtained solutions could be of practical importance since one could select which solutions is the most suitable for particular wastewater treatment system.

D2. Synergy between Industry 4.0 and Lean Methodology

Dragan PAVLOVIĆ, Peđa MILOSAVLJEVIĆ, Srđan MLADENOVIĆ

Faculty of Mechanical Engineering, University of Niš, Aleksandra Medvedeva 14, 18000, Niš, Serbia

Abstract. Following the ongoing trend of the manufacturing industry digitalization, a new industrial paradigm called Industry 4.0 has emerged as one of the most discussed concept. Industry 4.0 is changing the way the products are manufactured, integrating a smart network of machines and ICT systems and creating an intelligent factory. Lean is widely recognized methodology for improving productivity and decreasing costs in manufacturing organizations. Both of these approaches aim to increase productivity and flexibility. In recent years, there have been few studies and articles showing similarities and differences between Industry 4.0 and Lean methodology, and whether this two approaches are suitable for each other. The goal of this paper is to review the available literature on the relation between Industry 4.0 and Lean, and to show if they can complement each other or are in conflict.
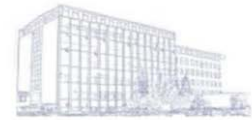
D3. Covid-19 Crisis Management in Manufacturing Industry Organizations in the Republic of Serbia

Ivana MARINOVIC MATOVIC[1], Andjela LAZAREVIC[2]

[1]*Addiko Bank AD, Belgrade, Serbia*

[2]*Faculty of Mechanical Engineering, University of Nis, Nis, Serbia*

Abstract. The crisis caused by coronavirus pandemic has led to major operational changes in manufacturing industry organizations. These organizations have faced the challenges of reducing or suspending the production process, due to restrictions imposed by the state, due to declining demand for their products, as well as due to the fact that their employees cannot do jobs remotely. Focusing on manufacturing industry in the Republic of Serbia, the paper investigates the problems faced by organizations in this sector after the outbreak of Covid-19 pandemic. Secondly, the paper examines the impact of Covid-19 crisis on various segments of their business, and the measures these organizations have taken to meet the major challenges that need to be addressed quickly. Finally, recommendations for successful crisis management in manufacturing industry organizations in the Republic of Serbia are derived. Recommendations include alternative tactics and innovative management concepts for overcoming problems, for survival, and preparing for economically viable operations of manufacturing industry organizations after the Covid-19 crisis.

D4. The Role and Importance of Standards for the Quality of Services in Educational Institutions in the Field of Mechanical Engineering

Andjela LAZAREVIC[a], Ivana MARINOVIC MATOVIC[b], Srdjan MLADENOVIC[a]

[a] Faculty of Mechanical Engineering, Aleksandra Medvedeva 14, 18.000 Nis, Serbia

[b] Addiko bank a.d., Bulevar Mihajla Pupuna 6, 11.070 Belgrade, Serbia

Abstract. Besides higher education activities, there is a complex range of services provided by the educational institutions in Serbia in the field of mechanical engineering. In order to provide balance between core activities related to the higher education and additional activities, in accordance with the national Law on higher education, good organization and synchronization of these activities is crucial. There are many tools and techniques that could be used to make this process more effective and easier. This paper considers the role and importance of standards implementation in educational institutions, especially related to the establishment of the quality and laboratory managements systems. The similarities, complementarity and differences of standards SRPS ISO 90001:2015 and SRPS ISO/IEC 17025:2017 are examined, together with challenges for their implementation.
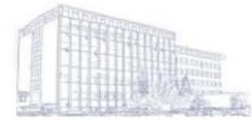
D5. A New Risk Management Model for Auto insurance in Serbia

Ivan RADOJKOVIĆ, Branislav RANĐELOVIĆ

First Author affiliation: Dunav Voluntary Pension Fund, Karadžićeva 8, Niš, Serbia

Second Author affiliation: University of Niš, Faculty of Electrical Engineering, Niš, Serbia

Abstract. Importance of automotive industry is significant in every country and economy. It affects the economic development of the country, and in last decade, the number of vehicles has been increasing every day, and hundreds and millions of vehicles are now traveling around the world. As a consequence, motor vehicle insurance is one of the most important branches of insurance. In this paper, we consider a general risk management model of motor vehicle insurance that is actual in Serbia. We propose change of this model and a modification in order to reduce the risk in car insurance, as well as to provide insurance to users with better service, in accordance with characteristics of vehicles. Modification of risk management model is based on mathematical approach and appropriate data analysis.

D6. Reengineering of Aluminium Melting and Casting Plants in Aluminum Processing Factory

Dragan TEMELJKOVSKI[1], Marko PAVLOVIC[2], Stojanče NUSEV[3], Dragana TEMELJKOVSKI NOVAKOVIĆ[4]

[1] *Faculty of Mechanical Engineering, University of Nis, Aleksandra, Niš, Serbia*

[2] *Aluminium processing plant "Alu Holding" d.o.o. Niš, Bulevar Sveti Car Konstantina, Serbia*

[3] *Faculty of Engineering, University St. Kliment Ohridski Bitola, I. L. Ribar bb, Bitola, Macedonia*

[4] *Research and Development Center "ALFATEC" Bulevar Nikole Tesla 63/5, 18000, Niš, Serbia*
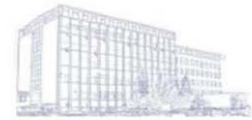
Abstract. This work shows the process of producing melting aluminum and casting of aluminum billets in the foundry of aluminium processing plant Alu Holding d.o.o. Niš by phase, as well as what are the success factors and risks in the development of this semi-product/product. The main causes of production problems that arise through different tools and methods have been analyzed, in order to find adequate solutions to reduce and eliminate them, as well as the ability to invest the company in automating this production process by purchasing a new casting table in the electromagnetic field, which would reduce the biggest production problem – scrap, reduce workplace injuries and ultimately improve overall operations. Finally, proposals for improvement – foundry reengineering, investment in its automation, as well as expectations and goals of implementing them are shown.

D7. Economic Challenges and Integration Engineering: The Smart Cities Context

Zorana KOSTIĆ

University of Niš, Faculty of Sciences and Mathematics

Abstract. The modern city development policy uses many new concepts including smart cities. In this regard, the implementation of the smart city concept has to be principally reasoned by ensuring higher efficiency and long-term sustainability. Understanding smart cities' importance has a fundamental role in facing new barriers, resolving problems and improving life quality. The aim of this research is to identify economic challenges and explore an engineering and managerial approach to the smart city concept. Smart cities are increasingly under pressure from challenges such as: high implementation costs, high energy consumption, integration of technology, smart management systems, infrastructure, and business changes. The special attention in the paper is devoted to the business process changes and using management tools, techniques, and approaches in the explanation a smart city as a large-scale enterprise.

D8. Energy Management Model for Sustainable Production Process – A Case Study

Milena RAJIĆ, Pedja MILOSAVLJEVIĆ, Rado MAKSIMOVIĆ, Dragan PAVLOVIĆ

First Author affiliation: Department of Management in Mechanical Engineering, University of Nis, Faculty of Mechanical Engineering, Nis, Aleksandra Medvedeva 14, 18000 Nis, Serbia

Second Author affiliation: Department of Management in Mechanical Engineering, University of Nis, Faculty of Mechanical Engineering, Nis, Aleksandra Medvedeva 14, 18000 Nis, Serbia

Third Author affiliation: Department of Industrial Engineering and Management, University of Novi Sad, Faculty of Technical Sciences, Novi Sad, Trg Dositeja Obradovića 6, 21000 Novi Sad, Serbia

Fourth Author affiliation: Department of Management in Mechanical Engineering, University of Nis, Faculty of Mechanical Engineering, Nis, Aleksandra Medvedeva 14, 18000 Nis, Serbia
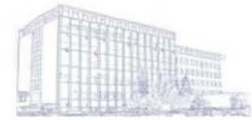
Abstract. Sustainable production processes in industrial organizations require the maximal added value with minimal resource utilization. Rational use of energy and energy resources represents an increasing challenge for companies in Serbia and in the world, all with the aim of preserving the environment. Research on material and energy flows, their correlations and the formation of models that are flexible and applicable to different production and service activities, would provide enough information to design processes with resource savings and negative impact on the environment. This paper presents the energy management model for energy profile identification of industrial organization in food industry sector. The energy flow was identified in order to have full insight in all energy consumption users.

D9. Personal Income and Aversion to a Sure Loss – Are Money-Makers willing to Risk More to Evade Certain Loss?

Miroslav FERENČAK, Dušan DOBROMIROV, Mladen RADIŠIĆ

Faculty of Technical Sciences, University of Novi Sad, Trg Dositeja Obradovića 6, 21000 Novi Sad, Serbia

Abstract. In this paper we will present the results of the research done to establish employment status as an influence for aversion to a sure loss under ambiguity. We recognized the need for such research in order to distinguish decision-making process between employed and non-employed persons. Basic behavioral effects that influence investment decision-making process are presented, together with the explanation of different states according to the information available on the market. The methodology is explained in detail, as as it is based on stock simulation rather than on hypotetical cases, and the subject group description is be presented. We utilized Fisher exact test together with descriptive statistics. The results are somewhat inconclusive, giving that there is no difference among two subject groups.
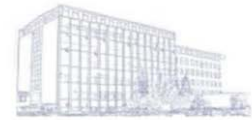
	Section E - Theoretical and applied mechanics and mathematics (*please access this link*) Section chairs: Dragan B. Jovanović, Predrag Rajković
1	**Julijana SIMONOVIĆ** *Mathematical Model of Bone Cells Adaptation on External Signals*
2	**Hedrih (Stevanović) R. Katica** *Running with nonlinear sciences – nonlinear mechanics and nonlinear dynamics*
3	**Hedrih (Stevanović) R. Katica** *Methodology of vibro-impact dynamics research on new theory of rolling body collisions*
4	**Ivan PETKOVIĆ, Đorđe HERCEG** *Computer Visualization of Popovski-like Methods for Solving Nonlinear Equations*
5	**Predrag RAJKOVIĆ, Slađana MARINKOVIĆ, Miomir STANKOVIĆ** *Functions Defined by Infinite Products and the Corresponding Equations*
6	**Dragana DIMITRIJEVIĆ JOVANOVIĆ, Ljiljana RADOVIĆ** *Parametric Modelling in Architecture*
7	**Ljiljana RADOVIĆ, Predrag RAJKOVIĆ** *Linearity of multiline path*
8	**Dragan B. Jovanović** *Reconstruction of Strain Energy Surfaces at The Crack Tip Vicinity*

E1. Mathematical Model of Bone Cells Adaptation on External Signals

Julijana SIMONOVIĆ

Department of Theoretical and Applied Mechanics, Faculty of Mechanical Engineering, University of Nis,

Abstract. Based on bone mechanobiology research, this paper develops computational analytical models in order to address and better understand mechanotransduction - the molecular mechanisms by which bone cells sense and respond to mechanical signals. Downstream autocrine and paracrine signalling in response to periodic excitation were modelled by cell population system of ordinary differential equations in order to better represent and predict long-term behaviour and consequences of bone cell loading.   The S-system (the generalized Lottka-Volterra system) is in charge and is solved deterministically together with its stochastic analog (Gillespie algorithm) used for cross-correlation analysis of the parameters. This research clearly shows the indispensability and beneficial effects of external excitation on balanced and regular bone cell activities.

E2. Running with Nonlinear Sciences – Nonlinear Mechanics and Nonlinear Dynamics

Katica STEVANOVIĆ HEDRIH

Mathematical Institute of Serbian Academy of Sciences and Arts, Belgrade, Serbia and Faculty of Mechanical Engineering at University of Niš, Serbia
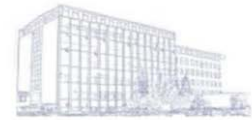
Abstract. It's been half a century since I've been running around and with Theoretical and Applied Mechanics, Nonlinear Oscillations, Non-linear Dynamics, as well as in general in Nonlinear Sciences. The impressive symposia and congresses of the International Union of Theoretical and Applied Mechanics (IUTAM), EuroMech Society, as well as the ICNO Conferences of the states of the former Eastern Bloc, or the Conference Series on Nonlinear Mechanics in Shanghai, China, should be noted. Also, must to listed following important Congresses: ICTAM Haifa 1993, Warsaw 2004, Adelaide 2008, Beijing 2012, Montreal 2016, World Congress of Nonlinear Analysis (IFNA WCNA) Orlando 2004 in America, et al. I dedicate this historical paper to School of asymptotic methods of nonlinear mechanics Krilov-Bogolyubov-Mitropolski, a group of the world important scientists, outstanding persons and academicians at the Soviet and Ukrainian Academies of Sciences, and on the occasion of the eleventh decade since birthday of Nikolay Nikolaevich Bogolyubov, great Soviet mathematician and mathematical physicist who has made important contributions in many areas of nonlinear sciences.

E3. Methodology of Vibro-Impact Dynamics Research on New Theory of Rolling Body Collisions

Katica STEVANOVIĆ HEDRIH

Mathematical Institute of Serbian Academy of Sciences and Arts, Belgrade, Serbia and Faculty of Mechanical Engineering at University of Niš, Serbia

Abstract. In this paper we start with new and general results on the dynamics of the body in rolling along curved lines given in general form, through the equations of curves in a stationary vertical plane or a vertical plane rotating with constant angular velocity about a vertical axis. In both cases, the generalized rolling pendulums, the corresponding nonlinear differential equations of dynamics of rolling body without slipping and their first integrals, ie the equations of phase trajectories, are derived. The complete Hedrih's theory of the impact and collision of heavy rolling balls, through geometry, kinematics and dynamics of rolling balls, is defined. Based on the both new Hedrih's results, theory of collision between rolling bodies and use phase trajectory method, a new methodology of vibro-impact dynamics investigation is founded and presented trough a number of applications in mechanical system dynamics.

E4. Computer Visualization of Popovski-like Methods for Solving Nonlinear Equations

Ivan PETKOVIĆ, Đorđe HERCEG

Faculty of Electronic Engineering, University of Niš, A. Medvedeva 14, 18000 Niš, Serbia

Faculty of Science, University of Novi Sad, Trg D. Obradovića 4, 21000 Novi Sad, Serbia

Abstract. The goal of this paper is computer visualization of Popovski-like methods for solving nonlinear equations of the form $f(z) = 0$ and the construction of a new one-parameter family of simultaneous methods for the determination of all simple zeros of a polynomial. For this purpose, advanced computer tools such as symbolic computation, basins of attraction and multi-precision arithmetic are employed. Choosing different values of the involved parameter, the presented family generates a variety of root-finding methods. Computer visualization of these methods indicates a conjecture on globally convergent properties of simultane-ous methods. Numerical examples and dynamic study are presented.

E5. Functions Defined by Infinite Products and the Corresponding Equations

Predrag RAJKOVIĆ, Slađana MARINKOVIĆ, Miomir STANKOVIĆ

Department of Mathematics, Faculty of Mechanical Engineering, University of Niš, Serbia,

Department of Mathematics, Faculty of Occupational Safety, University of Niš, Serbia,

Department of Mathematics, Faculty of Electronic Engineering, University of Niš, Serbia,

Abstract. In this paper, we deal with infinite products and functions defined by them. We examine the problems of numerical computing their values. Also, we consider a few modifications of the well-known methods for numerical solving of a equation or a system of equations. Especially, we included Newton's and the Newton-Kantorovich. The purpose was to adapt them to cases when the functions are given in the form of infinite products. The examples comprehend the infinite q-power products and prove that the methods are pretty suitable for them.
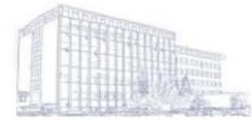
E6. Parametric Modelling in Architecture

Dragana DIMITRIJEVIĆ JOVANOVIĆ[1], Ljiljana RADOVIĆ[2]

[1] *Faculty of Civil Engineering and Architecture, University of Niš, A. Medvedeva 14, Niš, Serbia*

[2] *Faculty of Mechanical Engineering, University of Niš, A. Medvedeva 14, Niš, Serbia*

Abstract. Knowing the right input parameters and understanding geometrical logic, architects could achieve simultaneously a challenging aesthetic shape and an efficient functional design. Parametric modelling is a new approach to architectural design, using algorithms for the generation of virtual entities. The object, or model elements, could be generated automatically by internal logic arguments instead of being manually manipulated. Within this design process, architects could resolve visual, perceptive, material and structural issues while accomplishing significant time and precision improvements. This research paper aims to explore the position of parametric design in architectural practices and present the possibilities of algorithms in modelling architectural forms. Grasshopper will be considered as one of the graphical algorithm editors for a spiral staircase design.

E7. Linearity of Multiline Path

Ljiljana RADOVIĆ, Predrag RAJKOVIĆ

Department of Mathematics, Faculty of Mechanical Engineering, University of Niš, A. Medvedeva 14, Niš, Serbia
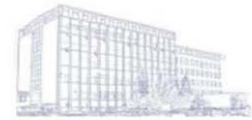
Abstract. Knowledge about the lines in an image is useful in many applications. There are requests for efficient image verification, identification and recognition. The mathematical tools for defining the shape descriptors are founded on: geometry, fractals, algebraic invariants, combinatorial methods, Fourier analysis, integral transformations, etc. Since every curve can be approximated by a multiline taking enough points, the multiline trajectories are very useful in analysing the linearity of a curve. Multiline itself can be easily represented by arc-length parameterization what gives us opportunity to examine its linearity by a few well-known methods or an integral transform. The whole theory can be extended to the other shapes and multidimensional problems. This procedure is also interesting from the point of view of comparing curves that can be used to determine the class to which a curve belongs, to analyse signatures, to check a batch of products, etc.

E8. Reconstruction of Strain Energy Surfaces at The Crack Tip Vicinity

Dragan JOVANOVIĆ

Faculty of Mechanical Engineering, University of Niš, A. Medvedeva 14, 18000, Niš, Serbia

Abstract. Results of applying the idea of reconstructing the spatial surface, that describes the potential strain energy distribution at the region of crack, and basic procedures of the reconstruction method, are presented. Relevant limitations and specificity of the method are pointed out in the evaluation of the the best fitting curves, and the best fitting three-dimensional surfaces of stress components, and potential strain energy. Based on the reconstructed potential strain energy surfaces, the isoenergy lines in front of the crack tip, are presented. It is observed that distribution of potential strain energy are very similar in both analysed cases, which indicates a significant influence of geometric shape of contour surfaces of the crack. For comparison, stress state and potential strain energy state, which are obtained by using relations from literature, are shown.

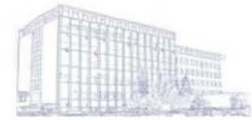|	**Section F - Energetics, energetic efficiency and process engineering, part 1** (*please access this link*) Section chairs: Mića Vukić, Mirko Stojiljković
1	**Saša PAVLOVIĆ, Velimir STEFANOVIĆ, Evangelos BELLOS, Christos TZIVANIDIS** *Solar Thermal Collector Efficiency Map: A New Evaluation Tool*
2	**Anna LIMANSKAYA, Goran VUČKOVIĆ, Mića VUKIĆ, Mirko STOJILJKOVIĆ** *Determination of the Equivalent Thermal Conductivity of an Inhomogeneous Building Block of Complex Geometry*
3	**Ljubov Sokolova, Saša PAVLOVIĆ, Tamara Tihomirova, Predrag Zivkovic, Velimir Stefanovic, Anna Limanskaya, Selishev Aleksei, Saša Pavlović** *Application of Solar Energy in Serbia and Russia*
4	**Jelena MALENOVIĆ-NIKOLIĆ, Dejan KRSTIĆ** *Engineering Management in Dealing with Emergencies in the Energy Industry*
5	**Marko MANČIĆ, Dragoljub ŽIVKOVIĆ, Mirjana LAKOVIĆ, Milena MANČIĆ, Milan ĐORĐEVIĆ** *A Model for Coupling Polygeneration System Superstructure Model to Building Load Models in Trnsys*
6	**Milica JOVČEVSKI, Miloš JOVANOVIĆ, Mirjana LAKOVIĆ, Marjan JOVČEVSKI** *Justification of Using Turbulators Stripes in Biomass Heating Stoves*
7	**Dragoljub ŽIVKOVIĆ, Milena RAJIĆ, Marko MANČIĆ** *Thermal Stresses of Hot Water Boiler Structure During the Process of Start-up*
8	**Mirko M. STOJILJKOVIĆ, Goran D. VUČKOVIĆ, Marko G. IGNJATOVIĆ** *Classification of Building Renovation Measures with Ensembles of Decision Trees*
9	**Ana MOMČILOVIĆ, Gordana STEFANOVIĆ, Biljana MILUTINOVIĆ, Dragiša SAVIĆ** *Assessment of Possible Organic Waste Inclusion and Implementation in Closed Loop System*
10	**Emir NOVALIĆ, Jelena JANEVSKI, Predrag ŽIVKOVIĆ, Mića VUKIĆ, Dejan MITROVIĆ** *Finned Radiator Thermal Characteristics Calculation*

F1. Solar Thermal Collector Efficiency Map: A New Evaluation Tool

Saša PAVLOVIĆ[a], Velimir STEFANOVIĆ[a], Evangelos BELLOS[b], Christos TZIVANIDIS[b]

[a]University of Niš Faculty of Mechanical Engineering, Niš, Republic of Serbia,

[b]National Technical University of Athens, School of Mechanical Engineering, Athens, Greece,

Abstract. Abstract This work presents the new concept of the solar collector efficiency map which is a two-dimensional depiction of the solar collector performance, with thermal efficiency in the horizontal axis and exergetic efficiency on the vertical axis. More specifically, this depiction includes results for various mass flow rates and inlet temperature levels in order to give the collector performance in different operating scenarios. The goal of this depiction is to present with a simple and direct way the optimum operating area of the collectorin order for the system designers to select the proper application for using every solar technology. In the present work, the commercial parabolic trough solar collector Eurotrough is investigated, as an example, with a validated thermal model developed in EES in steady-state conditions. The optimum operating conditions were found for inlet temperatures between 450 K and 650 K, while the mass flow rate has to be over 1 kg/s, according to the developed efficiency map. This map can be used in order to determine quickly both thermal end exergyefficiency and to know in which cases the collector has to be used for thermal or electricity applications.

F2. Determination of the Equivalent Thermal Conductivity of an Inhomogeneous Building Block of Complex Geometry

Anna LIMANSKAYA, Goran VUČKOVIĆ, Mića VUKIĆ, Mirko STOJILJKOVIĆ

University of Niš, Faculty of Mechanical Engineering in Niš, Aleksandra Medvedeva 14, 18000 Niš, Serbia

Abstract. Energy efficiency of buildings has worldwide importance. Construction standards imply use of increased building insulation thickness, resulting in thicker walls and increased occupation of usable space. Typical energy efficient masonry brick tends to lower specific density and has vertical empty holes which should trap air during proper construction. The last generation masonry brick available at the general market is a clay brick with vertical holes filled with insulation material. In this paper we considered inhomogeneous building block with complex geometry. We used the Hot Disk Thermal Constants Analyser to get thermal conductivity of clay and mineral wool of which the block consists. We derived the equivalent thermal conductivity 0.1297 W/mK for this block.
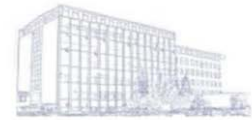
F3. Application of Solar Energy in Serbia and Russia

Ljubov SOKOLOVA[a], Saša PAVLOVIC[b], Tamara TIHOMIROVA[b], Predrag ZIVKOVIC[a], Velimir STEFANOVIC[a], Anna LIMANSKAYA[a], Selishev ALEKSEI[b]

[a]*University of Niš Faculty of Mechanical Engineering, Niš, Republic of Serbia*

[b]*Belgorod State Technological University named V.G. Shukhov, Power Engineering Institute, Belgorod, Russia*

Abstract. The global problem in the form of climate change is becoming more and more pronounced. As a result, most countries around the world are facing serious energy shortages, and forecasts indicate that such a situation will be similar in the near future. High consumption and population growth in the world will force the inhabitants of a large number of countries to face the problem of critical reduction of stocks of domestic fossil energy sources. The current energy dependence of most countries on oil and its derivatives requires significant economic expenditures and in the future suggests negative effects on national economies, as well as on the international security situation. Fossil fuel supplies are rapidly depleting, and within a decade or two, most countries will be forced to use renewable energy sources to meet their energy needs.Given the great relevance of the application of renewable energy sources around the world, this work aims to present the most commonly used, in terms of potential and opportunities, use in the field of solar energy in European countries: southeaster Serbia and eastern Russia. The main attention will be paid to solar concentration collectors, which are the most common and whose use from the technical-technological aspect has reached the highest level.In addition, economic indicators in terms of investment and exploitation profitability will be presented.

F4. Engineering Management in Dealing with Emergencies in the Energy Industry

Jelena MALENOVIĆ-NIKOLIĆ[1], Dejan KRSTIĆ[1]

[1] *Faculty of Occupational Safety, University of Niš, Čarnojevića 10a, Niš, Serbia*

Abstract. Engineering management is very important when dealing with emergencies. It is necessary to organize activities that rely on the available machinery to help preserve material and human resources. The energy industry cannot function properly during emergencies due to the seriousness of potential consequences. Events such as cracking dams due to heavy precipitation, collapsing wind turbine towers, fires in solar power plants, or corrosions in geothermal power plants warrant a more improved development of energy management in the use of renewables. There are also serious issues with the use of fossil fuels, particularly the use of coal, gas, oil, and oil shales, which require complex mining machinery. Engineering management in the energy industry is also crucial for a timely emergency response.

F5. A Model for Coupling Polygeneration System Superstructure Model to Building Load Models in Trnsys

Marko MANČIĆ, Dragoljub ŽIVKOVIĆ, Mirjana LAKOVIĆ, Milena MANČIĆ, Milan ĐORĐEVIĆ

First Author affiliation: Department of Energy and process engineering, University of Niš, Faculty of Mechanical Engineering, Aleksandra Medvedeva 14, Niš, Serbia

Second Author affiliation: Department of Energy and process engineering, University of Niš, Faculty of Mechanical Engineering, Aleksandra Medvedeva 14, Niš, Serbia
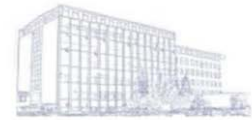
Third Author affiliation: Department of Energy and process engineering, University of Niš, Faculty of Mechanical Engineering, Aleksandra Medvedeva 14, Niš, Serbia

Fourth Author affiliation: Department of Energy processes and safety, University of Niš, Faculty of occupational safety, Čarnojevića 10a, Niš, Serbia

Fifht Author affiliation: Department of Mehcanical Engineering, University of Pristina, Faculty of Technical Sciences in Kosovska Mitrovica, Kosovska Mitrovica, Serbia

Abstract. A polygeneration system is an integrated energy system capable of providing multiple energy outputs to meet local demands. The system can consist of many polygeeration modules, including renewable energy modules and convention-al modules for transformation of available energy sources to meet the heating, cooling and electricity demands. The problems for operation of such system are related not only to following of heating and cooling loads, but also on integration criteria and engagement priority of each of the modules of the polygeneration system. In this paper, a model used for control of heat supply of a superstructure of a polygeneration system for heating and cooling supply of the consumer is presented. The model operates according to the set-point temperatures of the consumer, heat and cold storage. The presented model is based on application with TRNSYS software simulation environment.

F6. Justification of Using Turbulators Stripes in Biomass Heating Stoves

Milica JOVČEVSKI[1], Miloš JOVANOVIĆ[1], Mirjana LAKOVIĆ[1], Marjan JOVČEVSKI[2]

[1] *Faculty of Mechanical Engineering, University of Niš, Serbia,*

[2] *University "Ss. Cyril and Methodius", Faculty of Mechanical Engineering Skopje, North Macedonia*
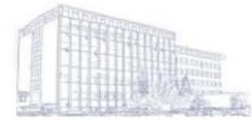
Abstract. In this paper, a mathematical model is examined for heat transfer at heat exchangers. The target is to obtain higher efficiency of a pellet stove, and from that, the heat transfer is the crucial parameters for their efficient operation. The stove which is analysed is operating on wooden mass pellets. Heated gasses flow through the pipes of the heat exchanger. The observed stove has 6 vertical gas pipes in the exchanger. Heat convection is achieved from the gasses to the internal pipe walls, observing the physical mechanism for the heat transfer coefficient in a turbulent boundary layer, where flow shear stress occurs as part from provoked increased turbulence i.e. Reynolds analogy, where the assumption being made is that the mechanisms of heat and momentum transfer are similar. With application of turbulator stripes in the pipes of the heat exchangers, internal heat transfer area increases, the shear stresses of the flow near the pipe walls is increased which leads to increased heat transfer efficiency and overall efficiency of the stove.

F7. Thermal Stresses of Hot Water Boiler Structure During the Process of Start-up

Dragoljub ŽIVKOVIĆ, Milena RAJIĆ, Marko MANČIĆ

Faculty of Mechanical Engineering, University of Niš, Serbia

Abstract. The maneuvering characteristics and safe operation conditions of hot water boilers are limited by thermal stresses of their structure. The greatest thermal stresses occur in non-stationary operating modes such as starting-up, changing operating mode or sudden shutdown due to protection system when permitted parameters are exceeded. Under these conditions uneven heating or cooling of the boiler element occurs, resulting in formation of large temperature gradients causing high thermal stresses. The paper presents the results of numerical and experimental analysis of the hot water boiler "Minel-Kotlogradnja", capacity 8.7 MW, during the process of starting-up. The aim of the paper was to determine the state of thermal stress of the hot water boiler structure during the process of starting-up and identifying the most important influencing parameters.

F8. Classification of Building Renovation Measures with Ensembles of Decision Trees

Mirko STOJILJKOVIĆ, Goran VUČKOVIĆ, Marko IGNJATOVIĆ

University of Niš, Faculty of Mechanical Engineering in Niš, Serbia

Abstract. Economic indicators of building renovation measures are often crucial in the process of decision-making related to buildings energy savings. The global cost is one of the widely used indicators for evaluating and comparing the measures. To perform an analysis with the appropriate precision, adequate models are necessary. The models based on physical phenomena are historically dominant, but recently data-driven surrogate models that use machine learning techniques started to gain the attention of the researchers in the buildings sector. This paper uses four classification methods to predict whether the global cost of a set of building renovation measures is above or below the predefined threshold. The results indicate that high prediction performance — with the F1 score, recall, and precision between 0.98 and 1 — can be achieved, except in the cases of very small training sets.

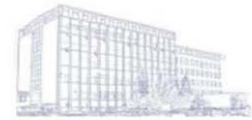### F9. Assessment of Possible Organic Waste Inclusion and Implementation in Closed Loop System

Ana MOMČILOVIĆ[1], Gordana STEFANOVIĆ[1], Biljana MILUTINOVIĆ[2] and Dragiša SAVIĆ[3]

[1] *Faculty of Mechanical Engineering, University of Niš, A. Medvedeva 14, Niš, Serbia*

[2] *College of Applied Technical Sciences Niš, A. Medvedeva 20, Niš, Serbia,*

[3] *Faculty of Technology, University of Niš, Bul. Oslobodjenja 124, Leskovac, Serbia*

Abstract. Organic waste, due to its characteristics, represents a challenging type of waste for implementation in the flows of circular economy, economic model based on closed loop system. The main idea of the paper is assessment of the inclusion possibility of different types of organic waste generated in the area of one city in the flows of the circular economy. For this purpose, a mathematical model was developed and applied. Based on the mathematical model, the optimum mixing ratio of the several organic waste fractions, which will be subjected to the anaerobic digestion treatment and composting, is determined. Developed scenarios are based on the organic waste types and quantities available in considered area. In each of the scenarios, process products, in the form of biogas and compost, are introduced into the flows of the circular economy. Based on the inputs and outputs in developed scenarios, the efficiency of the circular economy for each scenario is determined.
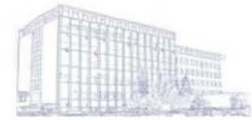
F10. Finned Radiator Thermal Characteristics Calculation

Emir NOVALIĆ, Jelena JANEVSKI, Predrag ŽIVKOVIĆ, Mića VUKIĆ, Dejan MITROVIĆ

Faculty of Mechanical Engineering, University in Niš, Serbia

Abstract. Water that is not well treated and maintained, despite all the benefits, may have devastating effect to the radiator body. Chemically untreated water can have a high PH value. Data collected while maintaining radiators in use has shown that with the increased PH value of water, corrosion occurs on the inner side of aluminium radiators. In addition to water quality treatment, one of the practical solutions is the addition of a steel pipe insert in the interior of the aluminium heater. Addition of the pipe insert increases the material thickness, and thus the overall heat conduction resistance. Increasing the heat conduction resistance affects the change in the heat transfer intensity of the radiator. The subject of this paper is research of the influence of a steel pipe insert on the heat transfer intensity of a finned aluminium heater. The method for stationary heat conduction through fines was used for analytical calculation.

Section G - Energetics, energetic efficiency and process engineering, part 2	
(*please access this link*)	
Section chairs: Miloš Jovanović, Živojin Stamenković	
1	**Miloš KOCIĆ, Živojin STAMENKOVIĆ, Jelena PETROVIĆ and Milica NIKODIJEVIĆ** *MHD Flow and Heat Transfer of Two Immiscible Micropolar Fluids*
2	**Jelena Petrović, Miloš Kocić, Milica Nikodijević, Jasmina Bogdanović-Jovanović** *Nanofluid Flow and Heat Transfer Between Horizontal Plates in Porous Media*
3	**Jasmina BOGDANOVIĆ JOVANOVIĆ, Živojin STAMENKOVIĆ, Jelena PETROVIĆ, Veljko BEGOVIĆ** *Operating and Acoustic Characteristics of Low-Pressure Centrifugal Fans with Backward Curved Blades*
4	**Filip Stojkovski, Zoran Markov, Valentino Stojkovski** *CFD Study of Radial Guide Vane Cascade with Convex and Concave Blade Sets for Variable Speed Francis turbines*
5	**Marija LAZAREVIKJ** *An Approach to Determine the Origin of Forces Acting on a Blade in a Cascade*
6	**Valentino STOJKOVSKI, Zoran MARKOV, Filip STOJKOVSKI** *Dilemmas for Choice an Installed Discharge at the Run-off River SHPP - Energy or Economic Approach*
7	**Živan SPASIĆ, Veljko BEGOVIĆ, Miloš JOVANOVIĆ, Saša MILANOVIĆ** *Numerical Research into the Influence of Impeller Reduction on Centrifugal Pump Performance*

G1. MHD Flow and Heat Transfer of Two Immiscible Micropolar Fluids

Miloš KOCIĆ[a], Živojin STAMENKOVIĆ[a], Jelena PETROVIĆ[a] and Milica NIKODIJEVIĆ[b]

[a]*Faculty of Mechanical Engineering, University of Niš, A. Medvedeva 14, 18000 Niš, Serbia*

[b]*Faculty of Occupational Safety Univerity of Niš, Čarnojevića 10a, 18000 Niš, Serbia*

Abstract. The steady flow and heat transfer of two incompressible electrically conducting micropolar fluids, between two infinite parallel plates, is investigated in this paper. The upper and lower plates have been kept at the two constant different temperatures and the plates are electrically insulated. Applied magnetic field is perpendicular to the flow and considered problem is in induction-less approximation. The general equations that describe the discussed problem under the adopted assumptions are reduced to ordinary differential equations and three closed-form solutions are obtained. The velocity, micro-rotation and temperature fields in function of Hartmann number, Reynolds number, the coupling parameter and the spin-gradient viscosity parameter are graphically shown and discussed.

G2. Nanofluid Flow and Heat Transfer Between Horizontal Plates in Porous Media

Jelena Petrović[1], Miloš Kocić[1], Milica Nikodijević[2], Jasmina Bogdanović-Jovanović[1]

[1] *Department of Hydroenergetics, Faculty of Mechanical Engineering Univerity of Niš, Aleksandra Medvedeva 14, 18000 Niš, Serbia*

[2] *Chair of preventive engineering, Faculty of Occupational Safety Univerity of Niš, Čarnojevića 10a, 18000 Niš, Serbia*
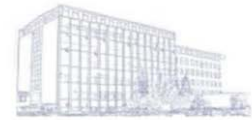
Abstract. In this paper, we have presented an analytical solution to the problem of MHD flow and heat transfer of nanofluid between horizontal plates in porous medium. Nanofluid is homogeneous, incompressible and electrically conducting. Horizontal plates are fixed and kept at different constant temperatures. Applied magnetic field is perpendicular to the plates while electric field is perpendicular to the vertical plane of the channel. Discussed problem is in induction-less approximation. The influence of important non-dimensional parameters on velocity and temperature fields are graphically illustrated and analysed in detail.

G3. Operating and Acoustic Characteristics of Low-Pressure Centrifugal Fans with Backward Curved Blades

Jasmina BOGDANOVIĆ JOVANOVIĆ, Živojin STAMENKOVIĆ,Veljko BEGOVIĆ

Department of Hydroenergetics, Faculty of Mechanical Engineering, Niš, Serbia

Abstract. Optimal fan operation ensures the optimum energy efficiency of the fan and, hopefully, the best acoustic characteristics of the fan. The enormous use of fans today, for various purposes, requires great energy resources, which is why the fan should operate at maximum efficiency. On the other hand, the noise characteristics of fans are just as important, and they are often a limiting factor for their application. Therefore, the prediction of fan noise in the operating regime is very important. With the development of numerical simulations, it is possible to determine its operating parameters and to perform analysis of the obtained results, in order to optimize its geometrical parameters. Many different centrifugal fans with backward-curved blades, which have the same dimensions of impeller and spiral casing, but different blade angles, were numerically simulated and analysed. The results of aerodynamic and acoustic characteristics of fans are presented in the paper.

G4. CFD Study of Radial Guide Vane Cascade with Convex and Concave Blade Sets for Variable Speed Francis turbines

Filip Stojkovski[1], Zoran Markov[2], Valentino Stojkovski[2]

Ss. Cyril and Methodius, University in Skopje
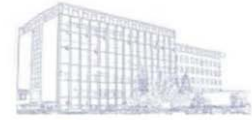
Faculty of Mechanical Engineering, Skopje

Abstract. The water flow conditions in front of the turbine runner, i.e. the turbine vaneless space is created from the guide vanes, which represents a radial (annular) cascade consisted of blades. It is characterized with their hydrofoil shape, their chord spacing and flow inlet and outlet angles, so an axisymmetric irrotational vortex flow condition in front of the runner is created. For variable speed operating conditions of the turbine, the flow parameters in front of the runner changes significantly. Investigations show that uniform shape of the guide vanes is insufficient for flow supply to the runner when variable speed operation is considered. A CFD analysis is carried out for a developed radial cascade in this paper. The blades have an asymmetric shape, positioned to the stream in a convex and concave manner, so to obtain shock free flow conditions in front of the cascade and in front of the runner. Furthermore, the aim is to determine the flow conditions in the cascade, the flow created in the vaneless space and how they influence on the turbine performance when variable speed operation is considered.

G5. An Approach to Determine the Origin of Forces Acting on a Blade in a Cascade

Marija LAZAREVIKJ

"Ss. Cyril and Methodius" University, Faculty of Mechanical Engineering-Skopje, Skopje, North Macedonia

Abstract. The flow characteristics and performance of a cascade depend on the mutual geometrical position of the blades. For the purpose of determining the origin of the forces acting on a blade in a cascade, the effect of the geometrical parameters that describe the cascade is analysed. Three different types of cascades are considered. Firstly, linear cascade consisting of equally spaced blades which are parallel to each other, defining a full overlap of inter-blade region is observed. The flow domain of the second cascade has a semi overlap of inter-blade region which is obtained with vertical displacement of each neighbouring blade. The third one is obtained by adding rotation of each blade for the value of pitch angle, with aim to present the specific fluid flow conditions in radial cascade. A new approach for analysing the origin of forces on blade in a cascade is suggested. The fluid flow domain between two consecutive blades in the cascade is divided into three characteristic zones: free flow inflow, inter-blade region and free flow outflow. CFD numerical modelling and simulations of two-dimensional steady and incompressible flow through the selected cascades are performed. Conclusions are drawn related to the influence of the zones on pressure distribution around blade and origin of forces in a cascade.

G6. Dilemmas for Choice an Installed Discharge at the Run-off River SHPP - Energy or Economic Approach

Valentino STOJKOVSKI, Zoran MARKOV, Filip STOJKOVSKI

"Ss. Cyril and Methodius" University, Faculty of Mechanical Engineering, Skopje, Republic of North Macedonia
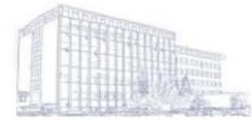
Abstract. In run-off river small hydropower plants (SHPP), the selection of installed discharge is very sensitive and depended on the designer's performances for basic parameter. The energy definition approach of the installed discharge is directly depends on the character of the flow duration curve and the choice of turbine equipment, presented by the production of electricity and the revenues received from the sale of electricity. If economic parameterization of the system is introduced through direct investments and costs for construction and maintenance, and represented through the index NPV, B/C, IRR, etc., then the definition of the installed discharge in the run-off river SHPP is different from the technically (energy) defined installed discharge. Software has been developed that through variation of the installed discharge, obtains the dependence of the variability of energy production, revenues (through a feed-in model for the produced electricity price), economic index parameters. The calculation model is developed on the basis of a matrix calculation of hydrological data for average monthly flows per years of a continuous series of hydrological years. The following technical parameters can be varied: type of turbine, number of units and diameter of penstock. On the base of maximal values per each parameter, different discharge is proposed as a result. Some comments and suggestions regarding turbine design to obtain installed discharge are given in this work.

G7. Assessment of Possible Organic Waste Inclusion and Implementation in Closed Loop System

Živan SPASIĆ, Veljko BEGOVIĆ, Miloš JOVANOVIĆ, Saša MILANOVIĆ

Department of Hydroenergetics, Faculty of Mechanical Engineering, Niš, Serbia

Abstract. Manufacturers of centrifugal pumps often predict the possibility of reducing the impeller of a pump. In this way, the pump performance can be quickly and simply adapted to the needs of the customer. The maximum reduction of the impeller depends on the pump type and usually varies from 5% to 20%. The characteristics of a pump with a reduced external diameter of the impeller can only experimentally be determined accurately. Similarity theory or some other related methods given in the literature are often used to approximate performance characteristics of pumps with reduced impellers. There is no complete geometric similarity between a pump and a pump with a reduced impeller, so the theory of similarity cannot be fully applied. Thus the changes in the performance of a pump with a reduced impeller are researched numerically. The aim of this paper is to validate the numerical simulation method for determining the performance of pumps with a reduced impeller. By mastering the numerical method of determining these characteristics, it is possible to reliably numerically predict the performance of pumps with other types of impeller reduction, without expensive and lengthy experiments.

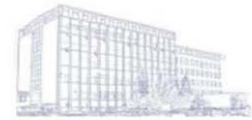|	Section H - Mechanical design, development and engineering, part 2 (*please access this link*) Section chairs: Dušan Stamenković, Milan Banić
1	**Dušan STAMENKOVIĆ, Milan BANIĆ, Milan NIKOLIĆ, Aleksandar MILTENOVIĆ, Uroš STANKOVIĆ** *Experimental Estimation of Footwear Slip Resistance*
2	**Sanjin TROHA, Jelena STEFANOVIĆ-MARINOVIĆ, Željko VRCAN** *Basic Kinematic Characterstics of Two-Speed Planetary Gear Trains with Brakes on Single Shafts*
3	**Mića ĐURĐEV, Eleonora DESNICA, Jasmina PEKEZ, Vladimir ŠINIK** *Optimization of the Speed Reducer Design Problem using Nature-inspired Algorithms*
4	**Aleksandar PETROVIĆ, Milan BANIĆ, Gavrilo ADAMOVIĆ** *Comparison of Interpolation and Approximation Curves and Their Application in Computer Graphics*
5	**Dejan MARIĆ, Mijat SAMARDŽIĆ, Tihomir MARSENIĆ, Tomislav ŠOLIĆ, Josip PAVIĆ, Ivan SAMARDŽIĆ, Božo DESPOTOVIĆ** *On-line Monitoring of MAG-CMT Welding Process*
6	**Marko PERIĆ, Aleksandar MILTENOVIĆ, Dušan STAMENKOVIĆ, Milica BARAĆ** *Surface Roughness of Parts Made by FDM 3D Printing*
7	**Aleksija ĐURIĆ, Dragan MILČIĆ, Damjan KLOBČAR** *Joining Lightweight Components by Resistance Element Welding - REW*

H1. Experimental Estimation of Footwear Slip Resistance

Dušan STAMENKOVIĆ[a], Milan BANIĆ[a], Milan NIKOLIĆ[b], Aleksandar MILTENOVIĆ[a], Uroš STANKOVIĆ[a]

[a]Faculty of Mechanical Engineering Niš, Aleksandra Medvedeva 14, Serbia,

[b]College of Applied Technical Sciences Niš, Aleksandra Medvedeva 20, Serbia

Abstract. Estimation of anti-slip characteristics of footwear and floor is the most important for the prevention of slipping accidents. Worldwide different countries have adopted various test methods to estimate the slip resistance of footwear and floor. Estimating the slip resistance is often conducted by measuring the coefficient of friction. Coefficient of friction can be determined by measuring of pulling force, friction angle (Ramp test) or energy loss (Pendulum test). Experimental research performed at Faculty of mechanical engineering in Nis is based on pulling force measurement. Measuring of friction force was performed on a test stand specially designed for that purpose. This test stand, test method and obtained measuring data are described in this paper.

H2. Basic Kinematic Characterstics of Two-Speed Planetary Gear Trains with Brakes on Single Shafts

Sanjin TROHA[a], Jelena STEFANOVIĆ-MARINOVIĆ[b], Željko VRCAN[a]

[a] *University of Rijeka, Faculty of Engineering, Vukovarska 58, Rijeka, Croatia*

[b] *University of Niš, Faculty of Mechanical Engineering, Aleksandra Medvedeva 14, Niš, Serbia*
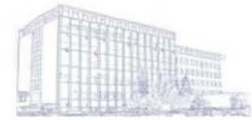
Abstract. This paper deals with compound two-carrier planetary gear trains (PGTs) with two coupled and four external shafts. Primarly, all possible structural schemes and systematization of these transmissions are pointed. Further research has been made into gear trains using coupling shafts for power input and output, with the controlling brakes acting on single external shafts. The transmission ratio of the PGT is changed by alternating activation of each brake. The kinematic schemes of all analysed PGT variants have been created, and the available transmission ratio ranges have been calculated for both speeds. Also, in some applications it can be necessary to achieve a predefined step between the two transmission ratios, with the actual transmission ratios being irrelevant. Since that, transmission ratio step is indicated too.

H3. Optimization of the Speed Reducer Design Problem using Nature-inspired Algorithms

Mića ĐURĐEV, Eleonora DESNICA, Jasmina PEKEZ, Vladimir ŠINIK

Department for Mechanical Engineering, Technical faculty "Mihajlo Pupin", Đure Đakovića bb, Zrenjanin

Abstract. Nature-inspired metaheuristic algorithms have recently grown very popular due to their simple implementation and flexibility. They are able to find quality solutions to optimization problems such as constrained engineering design problems. The attempt to solve the speed reducer design problem that belongs to this group has been emphasized in this study. The objective of this problem is to minimize the weight of speed reducer with seven design variables and eleven inequality constraints that speed reducer design should satisfy. Several modern nature-inspired metaheuristic algorithms are employed to optimize the speed reducer design. Comparative optimization results are obtained including minimal, mean, maximal and standard deviation values. The results prove nature-inspired algorithms are efficient techniques. However, additional improvements should be included in order to avoid local optima and achieve faster convergence.

H4. Comparison of Interpolation and Approximation Curves and Their Application in Computer Graphics

Aleksandar PETROVIĆ, Milan BANIĆ, Gavrilo ADAMOVIĆ

Department of Mechanical Design, Product Development and Engineering, Faculty of Mechanical Engineering, University of Niš, A. Medvedeva 14, Niš, Serbia

Department of Mathematics, Faculty of Mechanical Engineering, University of Niš, Serbia

Department of Mechanical Design, Product Development and Engineering, Faculty of Mechanical Engineering, University of Niš, A. Medvedeva 14, Niš, Serbia

Department of Computer Science, Faculty of Sciences and Mathematics, University of Niš, Serbia

Abstract. This paper deals with the application of interpolation and approximation curves in computer graphics. A graphical representation of Lagrange polynomials, Bezier curves, and cubic splines is considered. The paper presents software created for plotting the mentioned curves, programmed in the Python programming language. Special attention is paid to the comparison of these curves obtained for the same common points that the user can set by clicking the mouse button in the software windows.

H5. On-line Monitoring of MAG-CMT Welding Process

DejanMARIĆ[a], MijatSAMARDŽIĆ[b], TihomirMARSENIĆ[b], Tomislav ŠOLIĆ[a], Josip PAVIĆ[c], Ivan SAMARDŽIĆ[a]and BožoDESPOTOVIĆ[g]
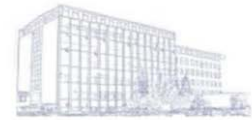
[a]*Mechanical engineering faculty in Slavonski Brod, University in Slavonski Brod, Slavonski Brod 35000, Croatia*

[b]*Đuro Đaković Power Station - ĐĐTEP, Dr. Mile Budaka 1, SlavonskiBrod, Croatia*

[c]*ĐĐ Kompenzatori d.o.o., Dr. Mile Budaka 1, SlavonskiBrod, Croatia*

[g]*DTZSB, SlavonskiBrod, Trg I. B. Mažuranić 2, SlavonskiBrod, Croatia*

Abstract. By applying the MAG-CMT welding process, it is possible to protect the boiler elements with Ni-alloys in order to prevent the harmful effects of corrosion. The researches gained insight into the influence of certain parameters of MAG-CMT process on the observed properties (content of delta ferrite less than 5% on the surface of the clad Ni-alloy, slight mixing of the base and filler material while retaining the adequate bonding of the substrate (base material) and the cladding layer (filler material), achieving the uniform thickness of the cladding layer, and reducing the rough transitions between the passages). Main welding parameters of the MAG-CMT process (current, voltage, filler wire feed rate, gas flow) are monitored and analyzed. Based on the observed parameters, the area of stable electric arc of MAG-CMT process is defined.

H6. Surface Roughness of Parts Made by FDM 3D Printing

Marko PERIĆ, Aleksandar MILTENOVIĆ, Dušan STAMENKOVIĆ, Milica BARAĆ

Faculty of Mechanical Engineering, University of Niš, A. Medvedeva Niš 18000, Serbia

Abstract. In this paper, the roughness of surfaces on samples made by 3D printing was examined. A total of nine printed samples with different 3D printing parameters were measured. In the laboratory, a 3D printer with FDM technology and PLA material for sample printing, a device for measuring surface roughness and a hand-held microscope were used. The change in surface roughness of samples with different 3D printing parameters was registered by measuring the parameter Ra and Rz which is defined as the average roughness. The 3D printing parameters considered are Print Speed, Flow material and Layer Height.

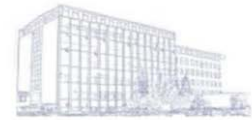### H7. Joining Lightweight Components by Resistance Element Welding - REW

Aleksija ĐURIĆ[a], Dragan MILČIĆ[b], Damjan KLOBČAR[c]

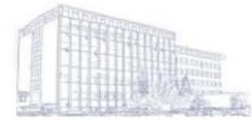*[a]University of East Sarajevo, Faculty of Mechanical Engineering, Bosnia and Herzegovina*

[b]Faculty of Mechanical Engineering, University of Nis, Niš, Serbia

[c]Faculty of Mechanical Engineering, University of Ljubljana, Ljubljana, Slovenia

Abstract. Resistance welding is a very cost- and energy-efficient welding process for thin sheets with wide distribution in the automotive manufacturing. With the challenges of lightweight construction in this area, new high-strength steel grades, light metals, and fiber-reinforced plastics are increasingly used. Hence, to that, adjustments of the welding processes are required. New process variants such as the resistance element welding (REW) are used to join mixed compounds of lightweight components and steel. Similar to the welding of functional elements, a low energy input in the base material is targeted, so only a small thermal influence of the materials occurs. The paper presents the mechanical properties, microstructure and macrostructure of the REW joint depending on the welding parameters.

	Section I - Production and information technologies (*please access this link*) Section chairs: Miodrag Manić, Predrag Janković
1	**David Potočnik, Lucijano Berus, Mirko Ficko** *Overview of grain size determination in metallography*
2	**Milos Milovancevic, Dragan Milčić Dalibor Petković** *ANFIS prediction of mean surface roughness and material removal rate in plasma arc cutting*
3	**Dragan RODIĆ, Marin GOSTIMIROVIĆ, Milenko SEKULIĆ and Anđelko ALEKSIĆ** *Application of fuzzy logic for modeling and predicting the electrical discharge machining accuracy*
4	**Pawan KUMAR** *Empirical model to predict surface roughness for drilling GFRP*
5	**Milan TRIFUNOVIĆ, Predrag JANKOVIĆ, Nikola VITKOVIĆ** *Optimization of Cutting Parameters for Minimizing Part Production Costs in Multi-Pass Rough Turning of EN-GJL-250 Grey Cast Iron*
6	**Miloš MADIĆ, Marko VELIČKOVIĆ, Nikola JOVANOVIĆ, Dimitrije PETROVIĆ** *Optimization of Variable Costs Considering Process Constraints in CO_2 Laser Cutting of P265GH Steel*
7	**Saša RANĐELOVIĆ, Mladomir MILUTINOVIĆ, Vladislav BLAGOJEVIĆ, Dejan MOVRIN** *The future of Manufacturing Processes with Support I4.0*
8	**Vladislav BLAGOJEVIĆ, Saša RANĐELOVIĆ, and Saša MILANOVIĆ** *The Expert System for Investigation of Hydraulic and Pneumatic Combinatory Automata - CAR-ex*
9	**Marko SIMONOVIĆ[1), Bogdan NEDIĆ[1), Milan SIMONOVIĆ[1), Dragan LAZAREVIĆ** *Comparison of optical measuring systems and CMM for smaller parts*
10	**Mileta JANJIĆ, Ramiz KURBEGOVIĆ, Milan VUKCEVIĆ** *Engineering Economic Analysis of Abrasive Water Jet Machining Quantitative Characteristics*
11	**Dušan PETKOVIĆ, Miloš MADIĆ, Goran RADENKOVIĆ** *Decision Support System for Biomaterial Selection*
12	**Milica BARAĆ, Nikola VITKOVIĆ, Miodrag MANIĆ, Marko PERIĆ** *A Review of Cutting Fluids in Manufacturing Engineering and Environmental Impact*
13	**Rajko TURUDIJA, Miodrag MANIĆ, Miloš STOJKOVIĆ** *Overview of Software for Simulation and Verification of G-code for CNC machine*

I1. Overview of Grain Size Determination in Metallography

David POTOČNIK, Lucijano BERUS, Mirko FICKO

Faculty of Mechanical Engineering, University of Maribor, Slovenia

Abstract. This paper represents an overview of methods for grain size determination in metallography, developed in recent years. Microstructures play an important role in the mechanical properties of alloy products, thus it is essential to precisely detect details such as shape, size and orientation of grains and other smaller defects. The most known and commonly used method for grain boundary detection is a microscopic examination, where experienced examiner interprets results. These results can be highly susceptible to the subjective assessment of the examiner. However, in recent years commonly known microstructure tasks in microstructure data science has begun to change by exploring the utilisation of machine vision and image processing. One of the approaches is machine vision based method for edge detection based on optical microscopy images set with different grain size values where evaluated performance based on intercept method is compared with the results, obtained by manual grain size determination method. Research has shown that a novel approach has the potential to automate the manual grain size determination process and thereby lower processing times.
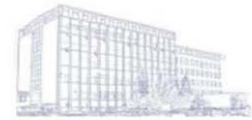
I2. ANFIS prediction of mean surface roughness and material removal rate in plasma arc cutting

Milos Milovancevic[1] Dragan Milčić[1] Dalibor Petković [2]

[1] *University of Niš, Faculty of mechanical engineering, A. Medvedeva 14, Nis, Serbia*

[2] *University of Niš, Pedagogical Faculty in Vranje, Partizanska 14, 17500 Vranje, Serbia*

Abstract. Plasma arc cutting process is very sensitive process which has to be optimized before application. There are different input factors which need adjustment in order to find the optimal combinations for the best final product. Therefore the main aim of the study was to establish predictive models for the plasma arc cutting in order to determine the cutting quality before real application of the plasma arc cutting. As cutting material Quard-400 was used. Input factors cutting speed and gas pressure were used during experimental procedure and for the predictive models crating. As the output quality parameters, mean surface roughness – Ra and material removal rate – MRR were used. Higher material rate means more profit for industry and vice versa. In the same time higher removal rate could increase surface roughness which is not desirable. Surface roughness needs to be minimized as much as possible which depends on the product application purpose. Predictive models were created based on adaptive neuro fuzzy inference system – ANFIS, which is suitable for nonlinear and redundant dataset. Results shown high predictive accuracy for the both output parameters.

I3. Application of Fuzzy Logic for Modeling and Predicting the Electrical Discharge Machining Accuracy

Dragan RODIĆ, Marin GOSTIMIROVIĆ, Milenko SEKULIĆ and Anđelko ALEKSIĆ

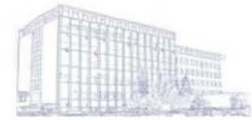*University of Novi Sad, Faculty of Technical Sciences, Novi Sad, Serbia*

Abstract. The dimensional accuracy of EDM is directly influenced by the gap distance created between the electrodes in the working zone. However, determining the gap distance between the tool (anode) and the workpiece (cathode) is a difficult point in this type of machining process. In this study a fuzzy logic theory is presented so that the EDM process can be modeled from the point of view of accuracy. The purpose is to develop a fuzzy logic model to analyze and predict the gap distance of the EDM process. The effect of the discharge current and the pulse duration was observed as developed input parameters. The fuzzy model offers a very advantageous option of the EDM input parameters to achieve the best machining accuracy. Moreover, the obtained model can be used in the generalization phase, where the gap distance information is needed and where direct measurement is not possible.

I4. Empirical model to predict surface roughness for drilling GFRP

Pawan KUMAR

Department of Mechanical Engineering, National Institute of Technology Kurukshetra, Kurukshetra - 136119, India

Abstract. The GFRP (glass fibre reinforced plastics) composites are finding up numerous application in many engineering and domestic fields due to their excellent mechanical properties and corrosion resistance. Maintain of proper surface roughness in drilling hole is very important and is to be controlled. In this work an attempt is made to predict surface roughness using empirical model. The experiment study is planed using Taguchi approach to know the influence of machining parameters on surface roughness. The experimental results are studied using analysis of variance and it is found the feed (36.84%) and drill diameter (27.33%) is the most affect parameter affecting the surface roughness. A machining parameter based model has been developed to predict the response parameter in drilling of glass fibre reinforced composite.

I5. Optimization of Cutting Parameters for Minimizing Part Production Costs in Multi-Pass Rough Turning of EN-GJL-250 Grey Cast Iron

Milan TRIFUNOVIĆ, Predrag JANKOVIĆ, Nikola VITKOVIĆ

Faculty of Mechanical Engineering in Niš, University of Niš, Aleksandra Medvedeva 14, 18106 Niš, Serbia
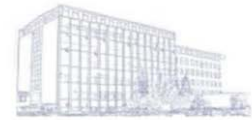
Abstract. The best way to reduce part production costs in turning is by increasing productivity, which is achieved by optimization of cutting parameters. Therefore, an optimization model for the multi-pass rough turning of grey cast iron, with part production costs considered as objective function, incorporating several practical constraints, was developed. The optimization problem was solved using a deterministic approach, i.e. brute force optimization algorithm, which guarantees the optimality of the optimization solutions in the given discrete space of input variables values. Results confirm that part production costs can be noticeably reduced by optimizing the main cutting parameters, compared to the part production costs for the cutting parameters recommended by the insert manufacturer. For the production of one part, part production costs can be reduced by 13,7 %, while unit production time can be reduced by 10,98 %. For the batch of 100 parts, total production costs can be reduced by 27,11 %, while total production time can be reduced by 25,18 %, leading to total savings of 44,44 EUR in production costs and 57,84 min in production time. In situations when the cutting parameters are adopted based on the insert manufacturer's recommendations, it is important to pay attention to certain constraints, such as the relationship between depth of cut and feed rate.

I6. Optimization of Variable Costs Considering Process Constraints in CO2 Laser Cutting of P265GH Steel

Miloš MADIĆ, Marko VELIČKOVIĆ, Nikola JOVANOVIĆ, Dimitrije PETROVIĆ

Department of Production and Information Technologies, Faculty of Mechanical Engineering in Niš, A. Medvedeva 14, 18000 Niš, Serbia

Abstract. In laser cutting, selection of cutting parameter values has significant influence on the production cost, material removal rate and different cut quality characteristics. In the present study, in order to find optimal cutting conditions for minimization of variable costs in CO2 laser cutting of P265GH steel, laser cutting optimization model was developed. In order to take into account cut quality characteristics, several process constraints were included in the optimization model. Experimental data, obtained upon realization of central composite design, were used so as to develop empirical models in terms of three process parameters such as cutting speed, assist gas pressure and nozzle diameter. The developed optimization problem was solved using interior-point algorithm and genetic algorithm. It was observed that with respect to currently used cutting conditions savings of around 40% can be made without compromising cut quality.

I7. The future of Manufacturing Processes with Support I4.0

Saša RANĐELOVIĆ[1], Mladomir MILUTINOVIĆ[2], Vladislav BLAGOJEVIĆ[1], Dejan MOVRIN[2],

[1]Production and Information Technology, Faculty of Mechanical Engineering, A. Medvedeva 14, 18000 Niš, Serbia

[2]Department for production engineering, Faculty of technical science, Trg D. Obradovića 6, Novi Sad, Serbia

Abstract. The fundamental objective I4.0 is to utilize the progress achieved in information and communications technologies (ICT) and that expected in the near future for the benefit of manufacturing enterprises. Preparation therefore has to be made for the increasing and consistent embedding of those technologies in production systems – and that in ever smaller partial systems and components. Additional communications capability and (partial) autonomy in reactions to external influences and internally stored specifications are transforming mechatronic systems into Cyber-Physical Systems (CPS). The objectives derived from that transformation are developments and adjustments in ICT for manufacturing applications: robustness, resilience, information security and real time capability.
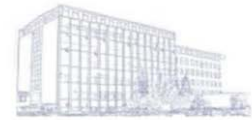
I8. The Expert System for Investigation of Hydraulic and Pneumatic Combinatory Automata - CAR-ex

Vladislav BLAGOJEVIĆ[1], Saša RANĐELOVIĆ[1], and Saša MILANOVIĆ[2]

Department of Production Information Technologies, Faculty of Mechanical Engineering, Niš, Serbia

Department of Hydroenergetics, Faculty of Mechanical Engineering, Niš, Serbia

Abstract. To examine the hydraulic or pneumatic combinatory automata realization, direct connection and control by the combinatory diagram are most frequently applied. This way of investigation is very slow, and if any errors occur re-connecting is usually required. The automated investigation of the hydraulic and pneumatic combinatory automats realization, no matter of the number of inputs and outputs, with the aid of the personal computer and by using purposely developed Expert system is presented in the paper. This enables to eliminate possible errors in connections and forbidden states before the realization itself takes place. In this paper, Clips (C Language Integrated Production System) is used as a tool for developing expert systems. The properties of the proposed expert system for investigation of combinatory automata realization (CAR-ex) are demonstrated by computer simulation.

I9. Comparison of Optical Measuring Systems and CMM for Smaller Parts

Marko SIMONOVIĆ[1], Bogdan NEDIĆ[1], Milan SIMONOVIĆ[1], Dragan LAZAREVIĆ[2]

[1] *Faculty of engineering University of Kragujevac*

[2] *Faculty of Technical Sciences in Kosovska Mitrovica, University of Pristina*

Abstract. This paper aims to compare the accuracy of measurement of modern optical measuring systems and coordinate measuring machines. It is characterized by the theoretical publication of the way of functioning and analysis of experimental tests of two measuring systems and each coordinate measuring machine. Data were compared for measurements. These are modern measuring systems ATOS and TRITOP and the coordinate measuring machine Tesa micro-hite 4-5-4. The measurements were performed on the part that has the role of a stopper in one assembly.

I10. Engineering Economic Analysis of Abrasive Water Jet Machining Quantitative Characteristics

Mileta JANJIĆ, Ramiz KURBEGOVIĆ, Milan VUKCEVIĆ

University of Montenegro, Faculty of Mechanical Engineering, 81000 Podgorica
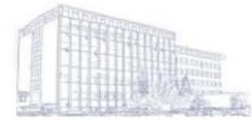
Abstract. Abrasive waterjet machining (AWJM) is one of the unconventional manufacturing technologies of recent date. To find a wider application in the industry and to improve its performance, it is necessary to understand the numerous input and output machining parameters and their interaction on the machining. This paper aims to investigate the effect of process parameters such as traverse speed and abrasive flow rate, on the abrasive water jet machining quantitative characteristics – productivity and price. All findings obtained during the investigation indicate that process parameters of the machining influence its quantitative characteristics.

I11. Decision Support System for Biomaterial Selection

Dušan PETKOVIĆ, Miloš MADIĆ, Goran RADENKOVIĆ

Faculty of Mechanical Engineering, University of Niš, A. Medvedeva 14, Niš, Serbia

Abstract. Biomaterials have a great impact on the functionality, durability and especially on the health safety of the implants. Biomaterial selection process is a complex and responsible multi-criteria decision making (MCDM) problem with specific and conflicting objectives. In order to help decision makers in solving this complex task, a decision support system named MCDM Solver is proposed. MCDM Solver is used in decision-making process to rank the biomaterials with respect to several criteria. In this paper, MCDM Solver was used to select hip prosthesis material.

I12. A Review of Cutting Fluids in Manufacturing Engineering and Environmental Impact

Milica BARAĆ, Nikola VITKOVIĆ, Miodrag MANIĆ, Marko PERIĆ

Faculty of Mechanical Engineering, University of Niš, Aleksandra Medvedeva 14, 18106 Niš
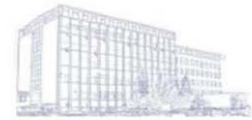
Abstract. Metalworking process is a major polluter of the environment due to cutting fluids in no small part. While on one hand cutting fluids have positive effects on tool life, surface quality and productivity, on the other hand they cause harmful effects on the environment and human health. In order to reduce the negative impacts, it is necessary to use more environmentally friendly cutting fluids, as well as reduce the use and losses of cutting fluids. In this paper, attention is focused on a review of cutting fluids and their characteristics as well as a review of the negative impacts of cutting fluids on the environment, human health and the economy.

I13. Overview of Software for Simulation and Verification of G-code for CNC machine

Rajko TURUDIJA, Miodrag MANIĆ, Miloš STOJKOVIĆ,

University of Niš, Faculty of Mechanical Engineering, A. Medvedeva 14, Niš, Serbia

Abstract. All companies want to be as efficient as possible. Engineers of companies that use CNC machines in their production spend a lot of time programming, and as a result provide G-codes. These codes are rarely checked before insertion into CNC machine, which can lead to collisions that causes financial damages. To avoid such damages it is recommended to use G-code simulation and verification software. These software check G-code before inserting it into the machine. In addition, these software provide features that can speed up the cutting process itself, such as cutting optimization, tool path optimization, tool life maximization etc. This paper presents a brief overview of some G-code simulation and verification software, with the aim of helping companies which production is based on use of CNC machines, mainly milling and lathe machines.

Section J - Traffic engineering, transport and logistic
(*please access this link*)
Section chairs: Boban Nikolić, Vesna Jovanović

1	**Ivan GRUJIĆ, Nadica STOJANOVIĆ, Jovan DORIĆ** *The Design of Unconventional Piston Mechanism for 3.0 L IC Engine*
2	**Nadica STOJANOVIĆ, Ivan GRUJIĆ, Jasna GLIŠOVIĆ, Danijela MILORADOVIĆ, Jovan DORIĆ** *Influence of Rear Spoiler Inclination on Aerodynamics and Stability of Car*
3	**Nikola PETROVIĆ, Vesna JOVANOVIĆ, Jovan PAVLOVIĆ, Jelena MIHAJLOVIĆ** *Determining the Impacts of Passenger Transport Modes on Air Pollution in the European Union*
4	**Tanja ŽIVOJINOVIĆ, Nataša BOJKOVIĆ, Marijana PETROVIĆ, Nikola PETROVIĆ** *Mobility as a Service: Key Topics and Challenges*
5	**Nikola SIMIĆ, Miladin STEFANOVIĆ, Aleksandar STANKOVIĆ, Goran PETROVIĆ** *Smart Technology Application in Spare Parts Management Processes in Company FRITECH*

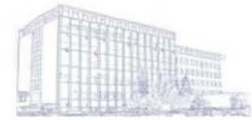## J1. The Design of Unconventional Piston Mechanism for 3.0 L IC Engine

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Abstract. The application of the IC engine as drivetrain represents long tradition, which will probably sustain and in the future. How the usage of IC engines is guaranteed, especially because new oil reserves are found every day, it should think about designing new, maybe better IC engines. In this paper is presented unconventional conception of the piston mechanism, which is more compact than classic, even for IC engine with relatively big displacement. Are shown geometrical differences and are listed advantages and disadvantages in the case of usage of such piston mechanism.

J2. Influence of Rear Spoiler Inclination on Aerodynamics and Stability of Car

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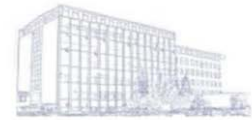
Abstract. The design of the vehicle has great influence on the aerodynamics and stability of the car. Today, how technology has achieved high level, traditional experiments performed on the road or in the laboratory can be replaced by virtual experiments. In order to reduce the time and costs for optimization of the rear spoiler setting angle, mainly specialized software for conducting virtual experiments were used. Determination of the optimal installation angle of the rear spoiler was performed by usage of the ANSYS software package, Fluid Flow CFX module. The angle of the spoiler starts from $-15° \div 15°$. Going from negative to positive angle (negative mathematical direction), lift force decreases, while this is not the case with aerodynamic force. However, the difference between the maximum and minimum aerodynamic force is about 12 N, which is negligible. While the difference between the maximum and minimum values of buoyancy force is about 130 N. So it is concluded that it is best to install the rear spoiler at $15°$ angle.

J3. Determining the Impacts of Passenger Transport Modes on Air Pollution in the European Union

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Abstract. Transport is one of the largest emitters of harmful substances that affect air quality. Each transport mode has different volume of passenger transport and at the same time has a differentiated negative impact on air quality. That is why in the European Union has been making special efforts for many years to create and implement strategies aimed at improving air quality. The main goal of this paper is to present a methodology that enables quantification and analysis of the impacts of each passenger transport mode on air quality using feed-forward neural networks. The developed model uses parameters for EU member states in the period from 2000 to 2014. In addition to the scientific and practical contribution, the development of model provides a good basic for the universal platform formation in order to create and develop strategies, i.e. measures to improve air quality on global level.

J4. Mobility as a Service: Key Topics and Challenges

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Abstract. Mobility as a Service (MaaS) represents an innovative concept that enables multi-modal daily travelling. Taking into account user preferences, MaaS combines different transportation options (e.g. public transport, taxi, sharing mobility services, etc.) through a single platform. Starting from the MaaS research findings, this paper summarises the main topics that are enjoying popularity in the scientific discussion. Also, the paper elaborates on key issues and challenges of MaaS running, with special emphasis on operational, social, financial and institutional related issues.

J5. Smart Technology Application in Spare Parts Management Processes in Company FRITECH

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Abstract. Information on the status of available resources in company Fritech d.o.o. is invaluable when planning the production process. Media of automatic identification technologies are used as carriers of labels with high data quality and adequate description of assets, in order to ensure a key level of stock visibility. Automatic product identification technologies in the process of work have become an integral part of modern business information systems of a large number of companies, and Fritech must adapt to needs, monitor its performance in order to see its position, advantages and disadvantages. A comparative analysis of the experiences and practices of the application of smart technologies of companies in the environment, provided the information basis for the justification of the application of automatic identification technologies in the storage system of the company Fritech. The material related to decision - making and multicriteria optimization is processed, the problem is set and the concrete application of the TOPSIS method in the selection of the type of automatic identification mark is presented.