



Faculty of Engineering  
University of Kragujevac



# **IRMES**

**KRAGUJEVAC**

**2019**

**9th International Scientific Conference - IRMES 2019**

**Research and Development of Mechanical Elements and Systems**

# **BOOK OF ABSTRACTS**

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Department for  
Mechanical Constructions and Mechanization

UNIVERSITY OF  
Kragujevac



FACULTY OF ENGINEERING



DEPARTMENT OF  
MECHANICAL  
CONSTRUCTIONS AND  
MECHANIZATION



9TH INTERNATIONAL SCIENTIFIC CONFERENCE - IRMES 2019

RESEARCH AND DEVELOPMENT OF MECHANICAL ELEMENTS AND  
SYSTEMS

# BOOK OF ABSTRACTS

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## FOREWORD

The 9th International Scientific Conference - IRMES 2019 - Research and Development of Mechanical Elements and Systems is organized by the Department for Mechanical Constructions and Mechanization of the Faculty of Engineering at the University of Kragujevac and the Association for Design, Elements and Constructions – ADEKO.

On the previous eight IRMES Conferences (the first in 1995, the last in 2017), around a thousand papers have been presented, and there were over a thousand participants from all over the world. A long and successful tradition is a stable basis for organizing this and future IRMES Conferences.

The mission of IRMES Conferences is to serve the global community by improving, spreading and applying new engineering knowledge, with the goal of being used as a source of the newest and most relevant information for mechanical engineers and experts in related fields – on a local, regional and global level.

Specific goals, themes and fields of the IRMES 2019 Conference are defined in cooperation with the ADEKO association, and in accordance with current topics and problems. Thematic units of the conference are: Mechanical Elements and Systems (modeling and simulation, loading and stress conditions, tribology, noise and vibrations, maintenance and monitoring, safety, quality, reliability), Power and Motion Transmission Systems (development of new concepts, modeling and simulations, noise and vibrations, testing, safety, quality, reliability), Product Development Process (technology transfer, creativity and innovations, development and design, Innovative product development, smart systems, industry 4.0, knowledge economy) and New Technologies and Materials (CAD/ CAM/ CAE technology, intelligent production systems, robotics and mechatronics, rapid prototyping, new materials).

We have ensured a wide international participation, in order to have as many high quality research papers as possible and in order to increase the significance and influence of IRMES Conferences on a global level. Of a total of over 180 submitted papers, authors of over 60% of the papers are from over 30 different foreign countries.

All submitted papers have undergone the process of international review, and of the submitted papers 140 were accepted which met the high set criteria. We would like to thank the reviewers on their hard work and dedication, which have increased the quality of the IRMES 2019 Conference.

This Book of Abstracts features extended abstracts of those papers, while the complete papers will be, according to authors' preferences be published through IOP Publishing Service in "IOP Conference Series: Materials Science and Engineering", or in one of six eminent journals.

Keynote lectures for the IRMES 2019 Conference will be held by prominent professors: Marco Ceccarelli - President of IFToMM, professor of Mechanics of Machines at the University of Rome Tor Vergata, Italy, Radoslav Martinović - retired professor at the University of Montenegro, Vojislav Miltenović - Chief of the Smart office 1 of the Innovation Center of the University in Nis (ICUN), and Milosav Ognjanović - professor emeritus at the University of Belgrade, Faculty of Mechanical Engineering. He is a full member of Academy for Engineering Sciences of Serbia – AESS and works for EDePro – Engine Design and Production.

Included in the IRMES 2019 Conference is also the Honorary Committee, which is made up of the most respected and experienced professors and researchers from the field of machine elements and design, with the goal of achieving continuity and a high quality of IRMES conferences to come.

Using good experiences from the previous IRMES 2017 conference, a student section will be organized again this year. Our goal is to spark interest in, and include, a large number of students, young and creative people, to work in the field of elements and design and to suggest new ideas and specific solutions, and to, through their participation in the conference, gain new experiences.

A large support for the organization of the Conference was provided by our sponsors. Aside from material help, it is important that a large number of companies understands and supports the importance of research and connecting results to practical application. We would like to thank our sponsors on their support.

The IRMES 2019 Conference will also include a number of other manifestations in order to ensure a high quality of exchanging knowledge and experiences, as well as a pleasant stay in Kragujevac in September of 2019.

We would like to thank all authors, committee members, reviewers, sponsors and others who have helped this Conference and attributed to its quality and importance.

To all participants we wish successful involvement in the IRMES 2019 Conference and a pleasant stay in Kragujevac.

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The IRMES Programme Committee is a constant body which decides on important matters for future IRMES conferences, such as: the organizer, time and place of conferences, themes, etc. The committee is made up of representatives from ADEKO member institutions and organizers of previous IRMES conferences.

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The honorary committee for IRMES 2019 is made up of members which have through their work and/or authority contributed to the development of machine elements and systems, as well as creating and maintaining IRMES conferences. Honorary committee members are from the ranks of distinguished academic citizens and experts specializing in relevant fields to the conference theme. The idea behind forming the Honorary committee as a permanent IRMES conference body is to show much deserved respect and appreciation to deserving researchers, and to have them actively and formally be included in the organization and workings of IRMES conferences.

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---

## CONTENTS:

### **KEYNOTE LECTURES**

1. **INNOVATIONS IN ROBOTICS WITH MECHANISM DESIGN** 2  
Marco Ceccarelli
2. **THE LUCAS CHAIR IN CAMBRIDGE FROM NEWTON TO HAWKING** 6  
Radovan Martinović, retired professor
3. **DEVELOPMENT OF INNOVATIVE AND SMART PRODUCTS** 10  
Vojislav Miltenović, Nenad Marjanović
4. **GEAR UNITS FOR EXTREME OPERATING CONDITIONS AND LOW WEIGHT - INNOVATIVE DESIGN AND TESTING -** 22  
Milosav Ognjanović, professor emeritus

### ***MECHANICAL ELEMENTS AND SYSTEMS (modeling and simulation, loading and stress conditions, tribology, noise and vibrations, maintenance and monitoring, safety, quality, reliability)***

5. **VIBROT - SOFTWARE FOR VIBRO-DIAGNOSTICS OF ROTATION MACHINE** 26  
R Tomović, D Bratić, M Mumović, V Vujošević, A Tomović
6. **STUDY OF OPERATING TEMPERATURE OF SPUR GEARS UNDER MIXED LUBRICATION CONDITIONS** 28  
J D Jovanović, R B Bulatović
7. **EFFECTS OF STRUCTURAL OPTIMIZATION ON PRACTICAL ROOF TRUSS CONSTRUCTION** 30  
Nenad Petrović, Nenad Kostić, Nenad Marjanović, Jelena Živković, Ileana Ioana Cofaru
8. **EFFECT OF FRICTION ON NOMINAL STRESS RESULTS IN A SINGLE TOOTH BENDING FATIGUE TEST** 32  
Mislav Vukić, Ivan Čular, Robert Mašović
9. **DETERMINATION OF THE PARASITIC FORCES THAT OCCUR AS A CONSEQUENCE OF THE MOVEMENT OF THE ROLLER OVER THE MINIATURE PROFILED GUIDE** 34  
V Kočović, S Kostić, S Vasiljević, Ž Santoši, A Košarac
10. **MACRO-ROUGHNESS HEIGHT DETERMINATION OF TEETH SURFACES OBTAINED BY GEAR GENERATING METHOD** 36  
Dmitry Babichev, Denis Babichev, Sergey Lebedev
11. **DELAMINATION ASSESSMENT OF COMPOSITE CURVED ANGLES USING SIMPLIFIED FEA MODELS BUILD-UP BY 2-D LAYERED SHELL ELEMENTS** 38  
Marius Nicolae Baba

---

12.	<b>REDESIGN OF THE BUCKET OF BUCKET CHAIN EXCAVATOR ERS1000/20 USING OF MODULAR DESIGN APPROACH</b>	40
	M Popović, I Milićević, G Marković, S Dragičević, M Marjanović	
13.	<b>CALCULATION OF A MANHOLE HATCH ON A TANK</b>	42
	S Dizdar, R Tomovic	
14.	<b>THE APPLICATION OF THE BALLISTIC PENDULUM FOR THE BULLETS VELOCITY MEASUREMENTS</b>	44
	Jovana Milutinović, Nebojša Hristov, Damir Jerković, Svetlana Marković, Aleksandra Živković	
15.	<b>FAILURE DIAGNOSIS AND PROGNOSIS OF SLIDING BEARINGS</b>	46
	Ranko Antunović, Nikola Vučetić, Amir Halep	
16.	<b>RESEARCH ON DESIGNING A MULTILoop PLANAR LINKAGE</b>	48
	Badoiu Dorin, Toma Georgeta	
17.	<b>TESTING STABILITY AND MANAGEABLENESS OF OSCILLATORY TRANSPORTING PLATFORM DURING THE SIEVING OF WET EARTH MASS</b>	50
	Goran Mihajlović, Milutin Živković	
18.	<b>SIMULATION OF EJECTOR FOR VACUUM GENERATION</b>	52
	Llorenc Macia, Robert Castilla, Pedro Javier Gamez	
19.	<b>RELIABILITY OF CYLINDRICAL TANK EXPOSED TO FIRE</b>	54
	Mirko Đelošević, Siniša Sremac, Goran Tepić	
20.	<b>ANALYSIS STATIC BEHAVIOUR OF BALL BEARINGS WITH TWO AND FOUR CONTACT POINTS</b>	56
	Aleksandar Živković, Miloš Knežev, Milan Zeljković, Mirjana Bojanić Šejat, Milivoje Mijušković, Slobodan Navalušić	
21.	<b>CONTACT PRESSURE ANALYSIS OF SLEWING RINGS</b>	58
	Rudolf Skyba, Slavomír Hrček, Jan Šteiner, Maroš Majchrák	
22.	<b>USE OF INDENTION VELOCITY DERIVATIVE FOR ESTIMATION OF ENVELOPE POINTS WHEN THE WRAPAROUND POINTS ARE KNOWN METHOD</b>	60
	Sergey Lebedev, Denis Babichev, Dmitry Babichev	
23.	<b>KINEMATIC METHOD OF ENVELOPE POINTS CALCULATION WHEN THE WRAPAROUND POINTS ARE KNOWN</b>	62
	Denis Babichev, Dmitry Babichev, Sergey Lebedev	
24.	<b>MODELING LATERAL CRACK BREATHING IN A ROTOR USING FINITE ELEMENT METHOD</b>	64
	Vesna Marjanović, Nenad Kostić, Nenad Petrović, Nicolae Florin Cofaru	
25.	<b>STRESS ANALYSIS OF LIFTING TABLE USING FINITE ELEMENT METHOD</b>	66
	Nebojša Rašović, Adisa Vučina, Milenko Obad	

---

26.	<b>AUTOMATIC MEASUREMENT OF PRECISION AND ACCURACY FROM THE HIT PATTERN OF SMALL ARMS USING ELECTRONIC TARGET SYSTEM</b>	68
	Aleksandra B Živković , Nebojša P Hristov, Damir D Jerković, Bogdan S Bogdanović, Jovana M Milutinović	
27.	<b>PARAMETER OPTIMISATION AND FAILURE LOAD PREDICTION OF RESISTANCE SPOT WELDING OF ALUMINIUM ALLOY 57547</b>	70
	Biljana Markovic, Marijana Krajišnik, Aleksija Đurić	
28.	<b>EXAMPLES OF KINEMATIC ANALYSIS OF COMPLEX MECHANISM USING MODERN SOFTWARE APPLICATIONS</b>	72
	Mustafa Imamović, Fuad Hadžikadunić, Amra Talić-Čikmiš, Armin Bošnjak	
29.	<b>THE RESEARCHES OF CARDAN SHAFTS / JOINTS DAMAGES IN THE EXPLOITATION</b>	74
	Aleksandar Ašonja, Eleonora Desnica	
30.	<b>THE RESPONSE OF A RANDOM VIBRATIONS OF NONLINEAR STRUCTURE UNDER WHITE-NOISE EXCITATIONS</b>	76
	Petre Stan, Marinică Stan	
31.	<b>RESPONSE STATISTICS OF SINGLE DEGREE OF NONLINEAR RANDOM STRUCTURE WITH NONLINEAR DAMPING CHARACTERISTIC AND NONLINEAR ELASTIC CHARACTERISTIC UNDER WHITE-NOISE EXCITATIONS</b>	78
	Petre Stan, Marinică Stan	
32.	<b>GEARS OR ROTORS - THREE APPROACHES TO DESIGN OF WORKING UNITS OF HYDRAULIC MACHINES</b>	80
	J Stryczek, S Bednarczyk, E Codina, P J Gamez-Montero, L Ivanovic, M Matejic	
33.	<b>DESIGN AND PERFORMANCE SIMULATION OF TORVEastro THREE-LINK ASTRONAUT ROBOT</b>	82
	Francesco Samani, Marco Ceccarelli	
34.	<b>TIGHTENS AS REQUIRED AND RESPONSIBLE ELEMENTS OF EQUIPMENT</b>	84
	Dusan Jesic, Pavel Kovac, Nenad Kulundžić, Dražen Sarjanovic	

***POWER AND MOTION TRANSMISSION SYSTEMS (development of new concepts, modeling and simulations, noise and vibrations, testing, safety, quality, reliability)***

35.	<b>OPTIMAL DESIGN OF SELF-RETAINING FULL COMPLEMENT CYLINDRICAL ROLLER BEARINGS</b>	88
	C Ursache, A Barili, L Tudose, C Tudose	

---

36.	<b>EXPERIMENTAL DETERMINATION OF PLASTIC GEAR DURABILITY</b>	90
	Gorazd Hlebanja, Matija Hriberšek, Miha Erjavec, Simon Kulovec	
37.	<b>EXPERIMENTAL INVESTIGATION OF CONVEYOR IDLERS OPERATIONAL CHARACTERISTICS</b>	92
	Radivoje Mitrović, Žarko Mišković, Zoran Stamenić, Nataša Soldat, Nebojša Matić, Mileta Ristivojević, Aleksandar Dimić	
38.	<b>RESEARCH OF WATER HYDRAULIC COMPONENTS AND SYSTEMS FROM ASPECTS OF QUALITY OF LIFE</b>	94
	Nenad Todić, Slobodan Savić, Saša Jovanović, Zorica Djordjević	
39.	<b>PLASTIC CUP STACKING MACHINE: PLANAR LINKAGE MECHANISM FOR GENERATION INTERMITTENT MOTION</b>	96
	Maja Čavić, Marko Penčić, Milan Rackov, Velibor Karanović, Marko Orošnjak	
40.	<b>ANALYSIS OF HARMONIC GEARBOX TOOTH CONTACT PRESSURE</b>	98
	Maros Majchrak, Robert Kohar, Michal Lukac, Rudolf Skyba	
41.	<b>EXSPERIMENTAL DETERMINATION OF WORM GEARING EFFICIENCY</b>	100
	Aleksandar Skulić, Blaža Stojanović, Saša Radosavljević, Sandra Veličković	
42.	<b>AN APPLICATION OF MULTICRITERIA OPTIMIZATION IN SELECTION OF THE TWO-SPEED TWO-CARRIER PLANETARY GEAR TRAINS</b>	102
	Sanjin Troha, Jelena Stefanović-Marinović, Branimir Rončević, Boban Anđelković, Miloš Milovančević, Kristina Marković	
43.	<b>ANALYSIS OF THE INFLUENCE OF DIRECTION OF HELICAL TEETH IN THE UNIVERSAL HELICAL GEAR REDUCER ON SERVICE LIFE OF THE BEARINGS THAT SUPPORT THE REDUCER SHAFT</b>	104
	Milan Rackov, Siniša Kuzmanović, Ivan Knežević, Maja Čavić, Marko Penčić, Darko Stefanović, Mircea Viorel Dragoi	
44.	<b>TRANSMISSION CHARACTERISTICS OF SIMPLE CYCLOID DRIVE WITH STEPPED PLANETS</b>	106
	Tihomir Mačkić, Milan Tica, Roland Šuba	
45.	<b>THE USE OF THE GAS FLOW MODEL TO IMPROVE THE DESIGN OF THE PISTON-RINGS-CYLINDER SYSTEM OF A DIESEL ENGINE</b>	108
	Grzegorz Koszalka	
46.	<b>IMPACT OF A DRIVING BELT LENGTH ON A DEVICE NOISE</b>	110
	Peter Zvolensky, Milan Benko, Lukas Lestinsky, Jan Dungal	
47.	<b>PRICE IMPACT ON ACOUSTIC COMFORT OF A WASHING MACHINE</b>	112
	Peter Zvolensky, Lukas Lestinsky, Jan Dungal	

---

- 
48. **DYNAMICS AND RIGIDITY OF SIMULATION CONTROL ON A 3-DOF MANIPULATOR** 114  
Serikbay Kosbolov, Gulnar Sadikova, Algazy Zhauyt,  
Saltanat Yussupova, Nurshat Uteliyeva, Dana Maksut

***PRODUCT DEVELOPMENT PROCESS (technology transfer, creativity and innovations, development and design, Innovative product development, smart systems, industry 4.0, knowledge economy)***

49. **CASE STUDY ON TOPOLOGY OPTIMIZED DESIGN FOR ADDITIVE MANUFACTURING** 116  
Abdulbasit M. Aliyi, Hirpa G. Lemu
50. **TRENDS OF USING POLYMER COMPOSITE MATERIALS IN ADDITIVE MANUFACTURING** 118  
Yohannes Regassa, Hirpa G. Lemu, Belete Sirabizuh
51. **AUTOMOTIVE RUBBER PART DESIGN USING MACHINE LEARNING** 120  
Dávid Huri, Tamás Mankovits
52. **ASSEMBLY SYSTEMS PLANNING WITH USE OF DATABASES AND SIMULATION** 122  
Stefan Vaclav, Peter Kostal, David Michal, Simon Lecky
53. **APPLICATION OF THE MULTI-CRITERIA DECISION MAKING IN THE SELECTION OF MATERIALS OF COMPOSITE SHAFTS** 124  
Z Djordjevic, S Jovanovic, S Kostic, M Blagojevic, D Nikolic
54. **IN APPLICATIVE IMPORTANCE OF THE ARTIFICIAL NEURAL NETWORKS APPLICATION IN KNOWLEDGE ECONOMY** 126  
A. Kitić, B Anđelković, M Milovančević, J Stefanović-Marinović
55. **DESIGN OF ALGORITHM FOR CREATION OF MODULAR LINES OF SPECIAL PURPOSE MACHINES IN THE AUTOMOTIVE INDUSTRY** 128  
Jan Galík, Róbert Kohár, Tomáš Capák
56. **TRANSACTION APPLICATIONS OF ENTERPRISE INFORMATION SYSTEM** 130  
Vanessa Prajová, Mária Homokyová, Martina Horvátová
57. **RESEARCH AND DEVELOPMENT THAT IS "LEAVING NO ONE BEHIND" – THE ROLE OF SCIENCE, TECHNOLOGY, AND INNOVATION IN FULFILLING THE 2030 AGENDA** 132  
Danilo Arsenijevic
58. **TOOLS OF ORGANIZATIONAL-ECONOMIC MECHANISM OF INTERNAL CONTROL FUNCTIONING** 134  
Margarita Aristarchova, Vadim Fakhrutdinov

59.	<b>COST-EFFECTIVE DESIGN OF THE MACHINE PRODUCTS FROM THE ASPECT OF THERMICAL AND THERMO-CHEMICAL TREATMENT</b>	136
	Svetislav Lj. Marković, Aleksandar Marinković, Bratislav Stojiljković, Dragoljub Veličković	
60.	<b>INNOVATIVENESS OF ENTERPRISES IN KNOWLEDGE ECONOMY</b>	138
	Vanja Vukojevic	
61.	<b>DESIGN OF TESTING RIG FOR PARAMETERS MEASUREMENTS OF ELECTRIC MULTICOPTER PROPULSION SYSTEM</b>	140
	Boris Marković, Janko Jovanović	
62.	<b>QUALITY OF EMPLOYEE EDUCATION, TRAINING NEEDS IN SMALL AND MEDIUM ENTERPRISES IN THE SLOVAK REPUBLIC</b>	142
	Ol'ga Poniščiaková, Ivan Litvaj, Juraj Makarovič	
63.	<b>MODEL OF «SHORT CYCLES» AS INNOVATIVE PRODUCT DEVELOPMENT</b>	144
	Elizaveta Gromova	
64.	<b>INDICATORS OF TAX RELIABILITY OF INNOVATIVE ACTIVITY</b>	146
	M K Aristarkhova, O K Zueva, M S Zueva	
65.	<b>MODELING OF DURATION OF TIME OF DEVELOPMENT AND REALIZATION OF INNOVATIVE PRODUCTS</b>	148
	M K Aristarkhova, M S Zueva, D A Abzgildin	
66.	<b>THE IMPORTANCE OF MEDICAL ENGINEERING IN THE IMPLEMENTATION OF THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT</b>	150
	Tina Aničić	
67.	<b>STUDY ACCURACY OF A TRANSPORTATION SYSTEM POSITIONING OF A TEST RIG FOR AUTOMATED MOUNTING OF LUSTER TERMINALS</b>	152
	R Dimitrova, V Zhmud, N Petrov, T Vakarelska	
68.	<b>AUTOMATION OF CANTILEVER RACKING DESIGNING PROCESS</b>	154
	Rodoljub Vujanac, Nenad Miloradovic, Pavle Zivkovic, Luka Petrovic	

***NEW TECHNOLOGIES AND MATERIALS (CAD/ CAM/ CAE technology, intelligent production systems, robotics and mechatronics, rapid prototyping, new materials)***

69.	<b>FATIGUE BEHAVIOUR OF FRICTION STIR WELDED AA-2024 ALUMINIUM ALLOY SHEETS</b>	158
	Tomaž Vuherer, Janez Kramberger, Dragan Milčić, Miodrag Milčić, Srečko Glodež	

---

70.	<b>INFLUENCE OF ORIENTATION TO FATIGUE BEHAVIOUR OF STEEL PARTS PRODUCED BY DMLS</b>	160
	Aleksandar Vranić, Snežana Ćirić Kostić, Nebojša Bogojević, Nusret Muharemović, Dario Croccolo, Giorgio Olmi	
71.	<b>CAD MODELLING OF THE CLOSING HIGH TIBIAL OSTEOTOMY</b>	162
	N F Cofaru, I I Cofaru, V Marjanović, N Marjanović, M Blagojević, R E Petruse	
72.	<b>MECHANICAL BEHAVIOUR OF SMALL LOAD BEARING STRUCTURES FABRICATED BY 3D PRINTING</b>	164
	N Palić, V Slavković, Ž Jovanović, F Živić, N Grujović	
73.	<b>MODELING OF 3D TEMPERATURE FIELD IN BUTT WELDED JOINT OF 6060 ALLOY SHEETS USING THE ANSYS PROGRAM</b>	166
	Mateusz Matuszewski	
74.	<b>POSSIBILITIES OF INTELLIGENT FLEXIBLE MANUFACTURING SYSTEMS</b>	168
	Peter Kostal, Andrea Mudrikova, Dávid Michal	
75.	<b>WELDING METHOD AS INFLUENTIAL FACTOR OF MECHANICAL PROPERTIES AT HIGH-STRENGTH LOW-ALLOYED STEELS</b>	170
	Andreja Ilić, Lozica Ivanović, Vukić Lazić, Danica Josifović	
76.	<b>COMPUTED TORQUE CONTROL FOR A SPATIAL DISORIENTATION TRAINER</b>	172
	Jelena Vidakovic, Vladimir Kvrđic, Mihailo Lazarevic, Pavle Stepanic	
77.	<b>QUALITY CONTROL OF CLOSED-CELL METAL FOAM PRODUCED BY DIRECT FOAMING</b>	174
	András Gábora, Tamás Mankovits	
78.	<b>DESIGNING AND OPTIMIZING EXTRACTORS FOR AUTOMATED DISPENSERS</b>	176
	Adrián Hajdučík, Lukáš Smetanka, Štefan Medvecký, Jozef Škrabala	
79.	<b>EFFECT OF REINFORCEMENT ON MECHANICAL CHARACTERISTICS OF A356 ALLOY NANOCOMPOSITES</b>	178
	Sandra Veličković, Blaža Stojanović, Zorica Djordjević, Slavica Miladinović, Jasmina Blagojević	
80.	<b>LASER CUTTING OF THE ZN COATED STEEL</b>	180
	Jozef Meško, Ružica R. Nikolić, Branislav Hadzima	
81.	<b>A REVIEW TO CAST POLYMER COMPOSITE MATERIALS FOR INTERIOR ENVIRONMENTS</b>	182
	Jasmina Blagojević, Bojan Mijatović, Dejan Kočović, Blaža Stojanović, Lozica Ivanović, Sandra Veličković	
82.	<b>REPARATORY SURFACE WELDING OF THE FRACTURED TOOTH OF THE BUCKET-WHEEL EXCAVATOR GIRTH GEAR</b>	184
	Dušan Arsić, Ružica Nikolić, Vukić Lazić, Aleksandra Arsić, Milan Mutavdžić, Nada Ratković, Branislav Hadzima	

---



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83.	<b>EXTENSION OF THE STEEL SIEVE DURING THE SPHERICAL GUN-POWDER SCREENING</b>	186
	Nada Bojić, Ružica Nikolić, Dragan Milčić, Milan Banić	
84.	<b>APPLICATION OF ARDUINO PLATFORM IN TECHNICAL SYSTEM</b>	188
	Natalija Tomić, Boban Anđelković, Miloš Milovančević, Marko Mladenović, Ana Kitić	
85.	<b>DATA ACQUISITION IN ARDUINO SYSTEMS</b>	190
	Natalija Tomić, Boban Anđelković, Miloš Milovančević, Marko Mladenović, Ana Kitić	
86.	<b>DESIGN OF WEARABLE OXIMETER MEDICAL DEVICE SUPPORTED BY MOBILE APPLICATION MONITORING</b>	192
	M Petrovic, N Grujovic, V Slavkovic, F Zivic	
87.	<b>EFFECT OF NANOSIZED PARTICLES ON THE BAINITIC TRANSFORMATION IN AUSTEMPERED DUCTILE IRONS</b>	194
	Valentin Mishev, Julieta Kaleicheva, Viktor Anchev, Zdravka Karaguiozova	
88.	<b>PARAMETER OPTIMISATION AND FAILURE LOAD PREDICTION OF RESISTANCE SPOT WELDING OF ALUMINIUM ALLOY 57547</b>	196
	Aleksija Đurić, Damjan Klobčar, Dragan Milčić, Biljana Markovic	
89.	<b>THE INFLUENCE OF DIFFERENT LAMINA POSITIONS ON BUCKLING PROPERTIES OF COMPOSITES PLATES UNDER BIAXIAL COMPRESSION</b>	198
	Dejan Jeremić, Nebojša Radić	
90.	<b>FRACTURE ANALYSIS DIAGRAM IN INTEGRITY ASSESSMENT OF HIGH-FREQUENCY WELDED CASING PIPES MADE OF API J55 STEEL</b>	200
	Ljubica Lazić Vulićević, Živče Šarkočević, Aleksandar Rajić, Milenko Stašević	
91.	<b>NON-WOVEN COMPOSITES INTENSIFICATION PROPERTIES FOR AIR FILTERS BY PLASMA PRE-TREATMENT</b>	202
	M P Neznakomova, M-L Klotz, D N Gospodinova	
92.	<b>ESTIMATION OF LASER CUTTING PROCESS EFFICIENCY</b>	204
	Constantin Cristinel Girdu, Laurentiu Aurel Mihail, Mircea-Viorel Dragoi	
93.	<b>SELECTION OF WELDING PROCESS FOR ASSEMBLING THE ALUMINUM TRUSS USING THE CES SELECTOR SOFTWARE</b>	206
	Dragan Adamović, Jelena Živković, Miloš Lazarević, Bogdan Nedić, Miroslav Živković, Fatima Živić	

---

**RESEARCH AND DEVELOPMENT IN FIELD OF VECIHLES AND TRANSPORT**

94. **ADVANTAGES OF USING DRONES VS HELICOPTERS IN CIVIL AIR TRANSPORT** 210  
Petar Mirosavljević, Miloš Marina, Dalibor Pešić,  
Radomir Mijailović
95. **VEHICLES OPTIMIZATION REGARDING TO REQUIREMENTS OF RECYCLING EXAMPLE: BUS DASHBOARD** 212  
Saša Milojević, Radivoje Pešić, Jovanka Lukić, Dragan Taranović,  
Tomas Skrucany, Blaža Stojanović
96. **ASSESSMENT OF DYNAMIC PROPERTIES OF A CARRIAGE USING MULTIBODY SIMULATION CONSIDERING RIGID AND FLEXIBLE TRACK** 214  
Ján Dižo, Miroslav Blatnický
97. **DETERMINING OF THE DRIVE POWER OF A TRANSPORT MACHINE FOR DISABLED PERSONS USING A COMPUTATIONAL MODEL** 216  
Miroslav Blatnický, Ján Dižo
98. **TECHNICAL SOLUTION OF THE UNDER LOCOMOTIVES VISUAL INSPECTION SYSTEM** 218  
Aleksandar Miltenović, Dušan Stamenković, Milan Banić,  
Miloš Simonović
99. **IMPROVEMENTS OF THE RANGE EXTENDER FOR A 48V ELECTRIC VEHICLE** 220  
Marcin Noga, Paweł Gorczyca, Radosław Hebda
100. **ANALYSIS AND FORMING COMPUTATIONAL MODEL OF ZIPLINE** 222  
Jovan Vladić, Tanasije Jojić, Radomir Đokić, Anto Gajić
101. **MATHEMATICAL MODELS OF VERTICAL TRANSPORT MACHINES AND METHODS FOR ITS SOLVING** 224  
Radomir Đokić, Jovan Vladić, Tanasije Jojić
102. **TANK CAR TESTING FOR DANGEROUS CARGOES TRANSPORTATION** 226  
Musij Kelrykh, Oleksij Fomin, Juraj Gerlici, Pavlo Prokopenko,  
Kateryna Kravchenko, Tomas Lack
103. **DETERMINATION OF THE STRENGTH OF THE CONTAINERS FITTINGS OF A FLAT WAGON** 228  
Oleksij Fomin, Juraj Gerlici, Alyona Lovska, Kateryna Kravchenko,  
Yuliia Fomina, Tomas Lack
104. **TRANSPORT AIRCRAFT MAINTENANCE INFLUENCE ON AIRCRAFT MARKET VALUE** 230  
Petar Mirosavljević, Nebojša Bojović, Dalibor Pešić, Radomir  
Mijailović, Miloš Marina

---

105.	<b>CONSTRUCTION OF THE HELICOPTER SIMULATOR AS A SCIENTIFIC RESOURCE</b>	232
	Petar Mirosavljević, Miloš Marina, Dalibor Pešić, Radomir Mijailović	
106.	<b>ESTIMATION OF THE INFLUENCE OF THE INTERACTION OF FACTORS PAIRS ON THE COEFFICIENT OF ROUTE EXECUTION POSSIBILITY</b>	234
	Volodymyr Puzyr, Oleksandr Krashenin, Denis Zhalkin, Yurii Datsun, Oleksandr Obozny	
107.	<b>APPLICATION OF DIGITAL HUMAN MODELS IN DETERMINATION OF THE PEDAL FORCE WHILE DRIVING</b>	236
	Slavica Mačužić, Jovanka Lukić	
108.	<b>INDOOR POSITIONING AND NAVIGATION SYSTEM FOR AUTONOMOUS VEHICLES BASED ON RFID TECHNOLOGY</b>	238
	Michal Regus, Rafal Talar, Remigiusz Labudzki	
109.	<b>SIMULATION OF VEHICLE'S LATERAL DYNAMICS USING NONLINEAR MODEL WITH REAL INPUTS</b>	240
	Danijela Miloradović, Jasna Glišović, Nadica Stojanović, Ivan Grujić	
110.	<b>RAILWAY CARRIAGE MASS IMPACT ON RETARDER NOISE</b>	242
	Peter Zvolensky, Marian Kollar, Lukas Lestinsky, Jan Dungal	
111.	<b>OPTIMIZING THE BRAKING SYSTEM FOR HANDLING EQUIPMENT</b>	244
	Daniel Varecha, Róbert Kohár, Tomáš Gajdošík	
112.	<b>MEASURING THE WEIGHT OF A VEHICLE BY MONITORING THE DYNAMIC TORQUE OF A HEAT ENGINE</b>	246
	Stefan Ionita, Corneliu Hagiescu, Bogdan Iovu, Stefan Velicu, Paul Paunescu	
113.	<b>EXAMINATION OF VEHICLE IMPACT AGAINST STATIONARY ROADSIDE OBJECTS</b>	248
	S Karapetkov, L Dimitrov, Hr Uzuniv, S Dechkova	
114.	<b>OPTIMALIZATION OF TRACTION UNIT FOR LOW-COST AUTOMATED GUIDED VEHICLE</b>	250
	Tomáš Capák, Róbert Kohár Jozef Škrabala, Ján Galík	
115.	<b>CONTROL STRATEGY FOR AFTERMARKET ELECTRONIC THROTTLE CONTROL</b>	252
	Jelena Prodanović, Boris Stojić	
116.	<b>OPTIMIZATION OF MAINTENANCE OF VEHICLES BASED ON COSTS</b>	254
	Vojislav Krstić, Božidar Krstić	

---

117.	<b>THEORY AND EXPERIMENTAL RESEARCH OF OPTIMAL CHARACTERISTICS OF HYDRODYNAMIC TRANSMISSIONS OF MOTOR VEHICLES</b>	256
	Vojislav Krstić, Božidar Krstić	
<b>RESEARCH AND DEVELOPMENT IN FIELD OF ENERGY AND ECOLOGY</b>		
118.	<b>DETERMINATION OF OPERATING PARAMETERS OF TURBINES FOR MICRO HYDROELECTRIC POWER PLANTS FOR OPTIMAL USE OF HYDROPOWER</b>	260
	Milutin Prodanović, Aleksandar Miltenović, Miroslav Nikodijević	
119.	<b>IMPACT OF SOURCE TEMPERATURE AT ELECTRIC FLOOR HEATING PANELS</b>	262
	Dragan Cvetković, Aleksandar Nešović	
120.	<b>INTEGRITY EVALUATION FOR THE AIR TANK OF THE REGULATION SYSTEM OF TURBINE AT HYDROPOWER PLANT</b>	264
	Miodrag Arsić, Vencislav Grabulov, Mladen Mladenović, Dušan Arsić, Zoran Savić	
121.	<b>COMPUTER-AIDED DESIGN OF 30 KW HORIZONTAL AXIS WIND TURBINE</b>	266
	D N Jovanović, V M Šušteršič	
122.	<b>LIFE CYCLE ASSESSMENT OF THE CAR TIRE WITH ECO-INDICATOR 99 METHODOLOGY</b>	268
	A Pavlović, D Nikolić, S Jovanović, G Bošković, J Skerlić	
123.	<b>ENERGY PERFORMANCE OF THE SERBIAN AND ESTONIAN FAMILY HOUSE WITH A SELECTIVE ABSORPTION FACADE</b>	270
	Nebojša Lukić, Aleksandar Nešović, Novak Nikolić, Andres Siirde, Anna Volkova, Eduard Latosov	
124.	<b>APPROXIMATION OF THE BRIDGE DECK DIFFUSION COEFFICIENT AND SURFACE CHLORIDE CONCENTRATION FROM FIELD DATA</b>	272
	Petr Koney, Petr Lehner, Dita Vorechovska, Martina Somodikova, Marie Hornakova, Pavla Rovnanikova	
125.	<b>INNOVATIVE SOLUTION OF FINE HORIZONTAL TRASH RACK FOR SMALL HYDROELECTRIC POWER STATIONS</b>	274
	Aleksandar Miltenović, Milutin Prodanović, Livia Beju, Vojislav Miltenović, Nikola Velimirović	
126.	<b>CALCULATION METHODOLOGY AND RESULTS OF PIPELINE STRESS ANALYSIS, SUPPORTS AND STEAM PIPELINE HANGING RECONSTRUCTION FOR RA FRESH STEAM PIPELINE AT POWER PLANT KOSTOLAC B WITH INCREASED FRESH STEAM FLOW RATE OF 1060 T/H AND NEW OPERATIONAL CONDITIONS</b>	276
	Dragan Živić, Vladimir Stevanović, Sanja Milivojević, Milan M Petrović, Đura Kesić	

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127.	<b>INSULATION IMPACT ON APPLIANCE ACOUSTIC CHARACTERISTICS</b> Peter Zvolensky, Lukas Lestinsky, Jan Dungal, Juraj Grecik	278
128.	<b>VIBROMECHANICAL DIAGNOSTICS OF URICANI MINE HOIST MACHINES</b> Mihai-Carmelo Ridzi, Răzvan-Bogdan Itu, Wilhelm Kecs, Vilhelm Itu	280
129.	<b>TECHNICAL CHARACTERISTICS, INVESTED FINANCIAL FUNDS AND EFFECTS OF THE PERFORMED MODERNIZATIONS OF THE FIRST INSTALLED EQUIPMENT OF TPP KOSTOLAC B</b> Miroslav Crncevic, Dragan Zivic, Milivoje Cvetkovic	282
 <b><i>SPECIAL SECTION "Toward a Sustainable Mobility"</i></b>		
130.	<b>TOWARD A SUSTAINABLE MOBILITY: A SOLAR VEHICLE FOR A NEW QUALITY OF LIFE</b> Giangiacomo Minak, Marko Lukovic, Stefano Maglio, Sinisa Kojic	286
131.	<b>PASSENGER CAR STEERING PULL AND DRIFT REDUCTION CONSIDERING SUSPENSION TOLERANCES</b> Mariano De Rosa, Alessandro De Felice, Cristiano Fragassa, Silvio Sorrentino	288
132.	<b>EXPERIMENTAL ANALYSIS OF JET SLURRY EROSION ON MARTENSITIC STAINLESS STEEL</b> Galileo Santacruz, Antonio Shigueaki Takimi, Felipe Vannucchi de Camargo, Carlos Pérez Bergmann	290
133.	<b>SOLUTION COMBUSTION SYNTHESIS OF Mo-Fe/MgO - INFLUENCE OF THE FUEL COMPOSITION ON THE PRODUCTION OF DOPED CATALYST NANOPOWDER</b> Rúbia Young Sun Zampiva , Carlos Pérez Bergmann, Annelise Kopp Alves, L Giorgini	292
134.	<b>SYNTHESIS OF COBALT FERRITE (COFe<sub>2</sub>O<sub>4</sub>) BY COMBUSTION WITH DIFFERENT CONCENTRATIONS OF GLYCINE</b> C G Kaufmann Junior, R Y S Zampiva, A K Alves, C P Bergmann, L Giorgini	294
135.	<b>FIRST ASSESSMENT ON SUSPENSION PARAMETER OPTIMIZATION FOR A SOLAR POWERED VEHICLE</b> Silvio Sorrentino , Alessandro De Felice, Pasquale Grosso, Giangiacomo Minak	296
136.	<b>SYNTHESIS OF Bi<sub>2</sub>Fe<sub>x</sub>NbO<sub>7</sub> FILMS APPLIED AS A CATALYST FOR HYDRO-GEN PRODUCTION USING VISIBLE-LIGHT PHOTO-ELECTROLYSIS</b> Allan Scharnberg, Ana Pavlovic, Annelise Alves	298

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137.	<b>COMPARING THE ACCURACY OF 3D SLICER SOFTWARE IN PRINTED END-USE PARTS</b>	300
	Milan Šljivić, Ana Pavlović, Milija Kraišnik, Jovica Ilić	
138.	<b>SEQUENTIAL DEPOSITION METHOD OF TiO<sub>2</sub>/CH<sub>3</sub>NH<sub>3</sub>PI<sub>3</sub> FILMS FOR SOLAR CELL APPLICATION</b>	302
	A E R T P Oliveira, F Bonatto, A K Alves	
139.	<b>NEW METHOD FOR MODELING THE TOPOGRAPHICAL PROPERTY OF METALS AND ITS APPLICATION IN ROBOT LASER HARDENING WITH OVERLAPPING</b>	304
	M Babič, G Lesiuk, L Giorgini	
140.	<b>PIEZOELECTRIC PVDF SENSOR AS A RELIABLE DEVICE FOR STRAIN/LOAD MONITORING OF ENGINEERING STRUCTURES</b>	306
	Sakineh Fotouhi, Roya Akrami, Kean Ferreira-Green, Mohamed Gamal Ahmed Naser, Mohamad Fotouhi, Cristiano Fragassa	
141.	<b>INNOVATION IN SOLAR VEHICLES: FROM CONCEPT TO PROTOTYPE IN LESS THAN 24 MONTHS</b>	308
	S Maglio, M Lukovic, N Zavatta, A Leardini	
142.	<b>TESTING METHODS AND EQUIPMENT FOR PALLETIZED PRODUCTS</b>	310
	A Greco, A Renzini, M Vaccari	
<b>STUDENT SECTION</b>		
143.	<b>VIRTUAL DEVELOPMENT PROCESS OF POWER GEAR TRANSMISSION</b>	314
	Nikola Rucić, Miloš Stanković, Damjan Rangelov, Miloš Stevanović, Jovan Arandžević, Dragan Milčić, Milan Banić	
144.	<b>PROOF OF CONCEPT FOR DESIGN OF NOVELTY HANDHELD VACUUM CLEANER GADGET USING ADDITIVE MANUFACTURING TECHNOLOGIES</b>	316
	Predrag Cvetković, Marko Pavlović, Tomica Mutavdžić, Kristina Milojević, Lozica Ivanović	
145.	<b>RECONSTRUCTION OF CUTTER FOR TEXTILE USING PRINCIPLES OF REVERSE ENGINEERING AND RAPID PROTOTYPING</b>	318
	Kristijan Micic, Srdjan Samardzic	
146.	<b>IMPROVEMENT OF IC ENGINE CRANK MECHANISM KINEMATICS USING NON-CIRCULAR GEARS</b>	320
	Dijana Čavić, Jovan Dorić, Milan Kostić, Nebojša Nikolić	
147.	<b>STRUCTURAL ANALYSIS OF CARDAN CROSS</b>	334
	Tomica Mutavdžić, Sandra Veličković	

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148.	<b>THE HEATING OF PLAIN BEARING LINING OF VARIOUS MATERIALS</b>	342
	Hristina Stojadinović, Miloš Radenković, Sandra Veličković	
149.	<b>MONITORING THE HARDNESS OF THE STEEL DEPENDING ON THE HARDENING PARAMETERS</b>	350
	Slobodan Živanović, Sandra Veličković	

## IMPACT OF SOURCE TEMPERATURE AT ELECTRIC FLOOR HEATING PANELS

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**Key words:** ANSYS Workbench, finite volume method, heat flux, heat transfer, floor panel, electric heating cables.

Among the panel systems, floor heating is the most widely used in Serbia because it offers characteristic advantages in terms of thermal comfort and final energy consumption. The uniform distribution of room temperature, lower temperature regime, easy installation, long service life, simple control, and the current low price of electricity are the reasons for the increasing use of electric heating cables (EHC) in floor heating systems. The application of low-temperature electric floor heating panels (LTEFHP) is limited to hygienic requirements (Table 1, Table 2), therefore the surface temperature of the floor should be uniform and within certain limits. The field of application of EHC in the construction of floor heating panels (Figure 1, Table 3) was investigated taking into account their mutual axial distance and temperature regime. The complete research was conducted numerically, using the finite volume method (FVM) in the ANSYS Workbench 14.5 software.

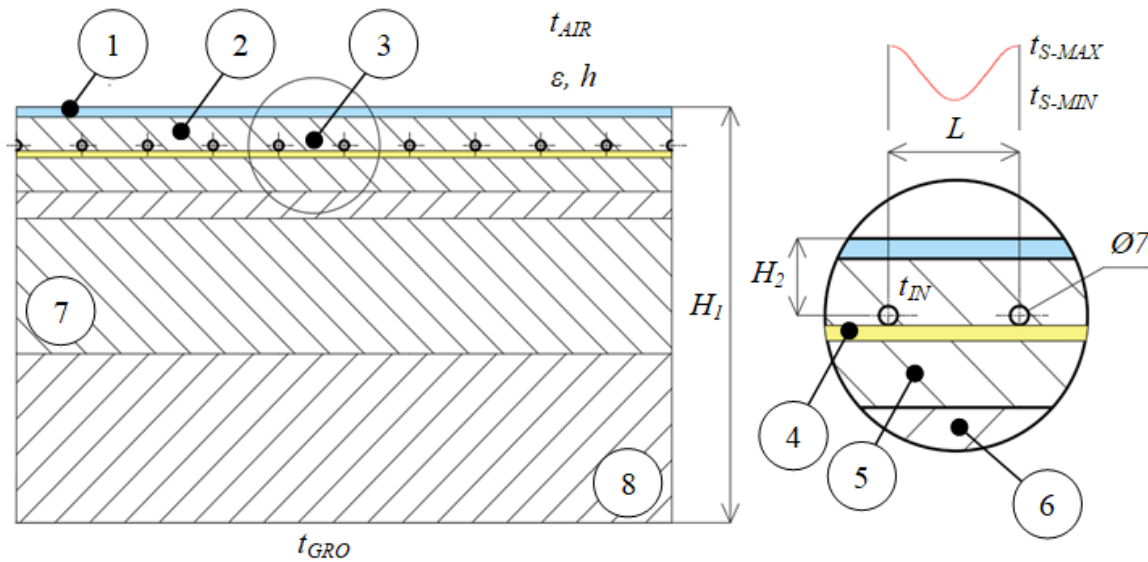
**Table 1.** The maximum floor temperature limit values depending on the LTEFHP application

Room category	Type of room	$t_{s-MAX}$ [°C]
I	In working rooms where a longer period of time is mostly standing	25
II	In residential and office spaces	28
III	In exhibition and similar halls	30
IV	In the bathrooms and swimming pools	32
V	In rooms where short stays, or through which only passes	35

**Table 2.** Simulation scenario

$t_{IN}$ [°C]	30	35	40	45	50
L [mm]	70; 80; 90; 100; 110; 120; 130; 140; 150; 160; 170; 180; 190; 200				





**Figure 1.** Initial boundary conditions before simulation of LTEFHP

**Table 3.** Characteristics of materials in the construction of the LTEFHP

Ordinal number	Material	H [m]	$\rho$ [kg/m <sup>3</sup> ]	$c_p$ [J/kgK]	$\lambda$ [W/mK]
1	Granite plates	0.012	2700	920	3.5
2	Cement screed	0.05	2200	1050	1.4
3	EHC	-			
4	PVC foil	0.001	1200	960	0.19
5	Styrofoam	0.05	33	1500	0.035
6	Reinforced concrete	0.04	2400	960	2.04
7	Ggravel layer	0.2	1700	840	0.81
8	Stone layer	0.25	1750	840	2.035

The results showed that LTEFHP can easily be used to heat residential and office space (category II) if the input temperature is 30°C in the floor heating panel. If the input temperature is 35°C, then it can be used to heat the exhibition and sports hall (L=115-200 Heating rooms IV and V category is possible with an input temperature of 40°C, but the application limit is quite shifted (L=163-200 mm for category IV). With an inlet temperature of 45°C it is possible to heat only the rooms of the V category, if the distance between EHC is 150-200 mm. Due to hygienic requirements, LTEFHP has no application for the input temperatures in the panel  $\geq 50^\circ\text{C}$ .

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