



THE ACADEMY
OF APPLIED STUDIES
POLYTECHNIC



International Scientific
and Professional Conference

Politehnika
2025

CONFERENCE PROCEEDINGS

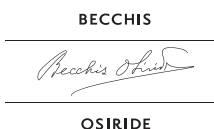
28th November 2025



Smurfit
Westrock



MOJ TRENUTAK DANA





International Scientific
and Professional Conference

**Politehnika
2025**

Conference Proceedings

28th November 2025
Sava Centar, 9 Milentija Popovića Street, Belgrade, Serbia

Publisher:

The Academy of Applied Studies Polytechnic
Katarine Ambrozić 3, Belgrade
www.politehnika.edu.rs

For the Publisher:

Marina Stamenović, PhD, Professor of Applied Studies

Thematic section editors:

Ivana Matić Bujagić, PhD
Svetozar Sofijanić, PhD
Aleksandra Nastasić, PhD
Nenad Đorđević, PhD
Željko Zdravković, PhDArts
Biljana Ranković Plazinić, PhD
Marko Jauković, PhD
Andrijana Đurđević, PhD
Tatjana Sekulić, PhD
Nikola Slavković, PhD

Technical preparation and cover design:

The Academy of Applied Studies Polytechnic, Organizing Committee

Design of the Conference logo:

Dušan Borović

Print:

The Academy of Applied Studies Polytechnic, Katarine Ambrozić 3, Belgrade

Year of Publishing:

2025

The circulation:

400



Conference Scopes

Environment and
Sustainable Development

Occupational Health
and Safety and Fire Safety

Smart Management Systems

Graphic Engineering

Design

Traffic Engineering

Biotechnology, Pharmacy
and Healthcare

Mechanical Engineering

Ecotourism and
Rural Development

Mechatronics

The Conference is supported by:

Ministry of Education, Republic of Serbia

Ministry of Science, Technological Development and Innovation, Republic of Serbia

Republic of Serbia - The Office for Dual Education and The National Qualifications Framework

Directorate for Occupational Safety and Health, Republic of Serbia

Chamber of Commerce of Belgrade

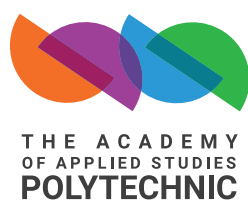
Institute for Standardization of Serbia

Serbian Automotive Cluster - AC Serbia

Center for the Promotion of Science

Engineering Academy of Serbia

Development Agency of Serbia



Organizer

The Academy of Applied Studies Polytechnic,

Katarine Ambrozić 3, Belgrade

www.politehnika.edu.rs

International Scientific Committee

assoc. prof. Filip Kokalj, PhD

Faculty of Mechanical Engineering, Maribor, Slovenia, president

prof. Luis Loures, *president of Portalegre Polytechnic University, Portalegre, Portugal*

prof. Andrea Matta, PhD, *Politecnico di Milano, Milano, Italy*

prof. Alessandro Gasparetto, PhD, *Polytechnic Department of Engineering and Architecture, Udine, Italy*

prof. Michalis Koniordos, PhD, *University of West Attica, Athens, Greece*

prof. Nihan Kahraman, PhD, *Yildiz Technical University Istanbul, Turkey*

prof. Anka Trajkovska Petkoska, PhD, *Faculty of Technology and Technical Sciences-Veles, North Macedonia*

prof. Yury Kuznetsov, PhD, *Orel State Agrarian University, Orel, Russia*

prof. Mohhamed-Salah Aggoune, PhD, *University of Batna 2, Algeria*

prof. Ilija Nasov, PhD, *Faculty of Technology and Technical Sciences-Veles, North Macedonia*

prof. Tihomir Latinović, PhD, *Faculty of Informational Technologies, Vitez University, Travnik, Bosnia and Herzegovina*

prof. Driss Nehari, PhD, *Ain Timouchen University, Algeria*

prof. Elizabeta Miskoska-Milevska, PhD, *Faculty of Agricultural Sciences and Food, Skopje, North Macedonia*

prof. Mirzo Selimić, PhD, *University College "CEPS – Centre for Business Studies", Kiseljak, Bosnia and Herzegovina*

assoc. prof. Srećko Stopić, PhD, *Aachen University, Germany*

assoc. prof. Anja Bubik, PhD, *Faculty of Environmental Protection, Velenje, Slovenia*

assoc. prof. Plamen Zahariev, PhD, *University of Ruse "Angel Kanchev", Ruse, Bulgaria*

Muharrem Hilmi Aksoy, PhD, *Konya Technical University, Konya, Turkey*

Darko Ljubić, PhD, *McMaster University, Hamilton, Canada*

Gregor Rak, MSc, *Vocational College of Traffic and Transport, Maribor, Slovenia*

Helena Mladenović Jerman, *director, School Center Ljubljana, Higher Vocational College, Slovenia*

prof. Mirjana Kijevčanin, PhD, *dean of Faculty of Technology and Metallurgy, Belgrade, Serbia*

prof. Srđan Glišović, PhD, *dean of Faculty of Occupational Safety, Niš, Serbia*

prof. Aleksandar Petrović, PhD, *Faculty of Mechanical Engineering, Belgrade, Serbia*

prof. Petar Uskoković, PhD, *Faculty of Technology and Metallurgy, Belgrade, Serbia*

prof. Aleksandar Jovović, PhD, *Faculty of Mechanical Engineering, Belgrade, Serbia*

assoc. prof. Biserka Vukomanović Đurđević, PhD, *Military Medical Academy, Belgrade, Serbia*

assoc. prof. Gordana Nikolić, PhD, *dean of PAR University of Applied Sciences, Rijeka, Croatia*

Marina Stamenović, PhD, *president of The Academy of Applied Studies Polytechnic, Belgrade, Serbia*

Program Committee

prof. Slaviša Putić, PhD

Faculty of Technology and Metallurgy, Belgrade, Serbia, president

prof. Vojkan Lučanin, PhD, *Faculty of Mechanical Engineering, Belgrade, Serbia*

prof. Aleksandar Marinković, PhD, *Faculty of Technology and Metallurgy, Belgrade, Serbia*

prof. Momir Prašćević, PhD, *Faculty of Occupational Safety, Niš, Serbia*

prof. Jelena Ivanović Vojvodić, PhD, *Faculty of Contemporary Arts, Belgrade, Serbia*

prof. Katarina Lončarević, PhD, *Faculty of Philology and Arts, Kragujevac, Serbia*

prof. Petar Spalević, PhD, *Faculty of Technical Sciences, Kosovska Mitrovica, Serbia*

assoc. prof. Zoran Štirbanović, PhD, *Technical Faculty, Bor, Serbia*

assoc. prof. Vladimir Pavićević, PhD, *Faculty of Technology and Metallurgy, Belgrade, Serbia*

assoc. prof. Katarina Trivunac, PhD, *Faculty of Technology and Metallurgy, Belgrade, Serbia*

doc. Maja Đolić, PhD, *Faculty of Technology and Metallurgy, Belgrade, Serbia*

Danica Stojiljković, PhD, *University of Belgrade – Institute for Multidisciplinary Research, Belgrade, Serbia*

Aleksandra Patarić, PhD, *Institute for Chemistry, Technology and Metallurgy, Belgrade, Serbia*

Ivana Jovičić, PhD, *Institute of Pesticides and Environmental Protection, Belgrade, Serbia*

Predrag Maksić, PhD, *Academy of Applied Studies Polytechnic, Belgrade, Serbia*

Dominik Brkić, PhD, *Academy of Applied Studies Polytechnic, Belgrade, Serbia*

Aleksandra Nastasić, PhD, *Academy of Applied Studies Polytechnic, Belgrade, Serbia*

Tatjana Marinković, PhD, *Academy of Applied Studies Polytechnic, Belgrade, Serbia*

Predrag Drobnjak, PhD, *Academy of Applied Studies Polytechnic, Belgrade, Serbia*

Goran Zajić, PhD, *Academy of Applied Studies Polytechnic, Belgrade, Serbia*

Organizing Committee

Ana Popović, PhD, president

Nebojša Ćurčić, MSc, deputy president

Ana Slavković, PhD

Dragana Gardašević, PhD

Dragana Kuprešanin, PhD Arts

Aleksandra Božić, PhD

Markola Saulić, PhD

Tatjana Sekulić, PhD

Novak Milošević, MSc

Aleksandra Janićijević, MSc

Ana Cvijanović, MA

Natalija Gaković, MA

Aleksandra Božović, MSc

Milan Marković, MSc

Jelena Pavlović, MSc

Dragica Nikodinović, PhD Arts

Melita Maleski, MSc

Miloš Kocić, MA

Boško Medaković, MSc

Reviewers

Svetozar Sofijanić, PhD, Marta Trninić, PhD, Radenko Rajić, PhD, Nikola Tanasić, PhD, Snežana Knežević, PhD, Barbara Vidaković Ristić, PhD, Nebojša Ćurčić, MSc, Novak Milošević, MSc, Filip Kokalj, PhD, Ana Popović, PhD, Aleksandra Božić, PhD, Ivana Matić Bujagić, PhD, Dominik Brkić, PhD, Olivera Jovanović, PhD, Vesna Alivojvodić, PhD, Darko Ljubić, PhD, Aleksandra Janićijević, PhD, Tatjana Sekulić, PhD, Marko Pavlović, PhD, Vladanka Stupar, PhD, Marko Jauković, PhD, Tatjana Marinković, PhD, Michallis Koniordos, PhD, Plamen Zahariev, PhD, Anka Trajkovska Petkoska, PhD, Ilija Nasov, PhD, Aleksandra Nastasić, PhD, Dragana Gardašević, PhD, Koviljka Banjević, PhD, Saša (Mirko) Marković, PhD, Zorica Baroš, PhD, Ana Slavković, PhD, Bosiljka Srebro, PhD, Aleksandra Pavlović, PhD, Brankica Pažun, PhD, Nebojša Andrijević, PhD, Jasmina Đurašković, PhD, Nikola Slavković, PhD, Dragan Kreculj, PhD, Željko Zdravković, PhD, Dejan Vračarević, PhD, Dragica Nikodinović, PhD, Goran Zajić, PhD, Maja Milinić Bodanović, PhD, Oliver Tomić, PhD, Natalija Simeonović, PhD, Anamarija Vartabedijan, PhD, Ivana Desnica, PhD, Dušanka Komnenić, PhD, Jelena Zdravković, MA, Natalija Gaković, MA, Ana Cvijanović, PhD, Ivan Erkić, MA, Milan Krstić, MA, Dejan Vukadinović, MA, Nikola Tanasić, PhD, Đorđe Dihovični, PhD, Saša (Milan) Marković, PhD, Bogdan Marković, PhD, Đorđe Đurđević, PhD, Andrijana Đurđević, PhD, Nataša Soldat, PhD, Obrad Aničić, PhD, Dragan Kreculj, PhD, Goran Nestorović, PhD, Milanka Plavšić, MA, Biljana Ranković Plazinić, PhD, Željko Ranković, PhD, Dragana Velimirović, PhD, Nada Ratković Kovačević, PhD, Dejan Jovanov, PhD

Foreword

The International Scientific and Professional Conference POLITEHNIKA 2025 represents the eighth edition of the POLITEHNIKA scientific and professional events, occurring biannually since its inaugural event in 2011. POLITEHNIKA 2025 upholds a distinguished tradition and commitment to integrating higher education and practical application across a diverse spectrum of disciplines represented by defined thematic scopes.

Organized with the patronage of the Ministry of Education of the Republic of Serbia, the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, the Directorate for Occupational Safety and Health, the Office for Dual Education and National Qualifications Framework, the Chamber of Commerce of Belgrade, the Institute for Standardization of Serbia, Serbian Automotive Cluster - AC Serbia, Center for the Promotion of Science, Engineering Academy of Serbia and the Development Agency of Serbia, POLITEHNIKA 2025 stands as a collaborative platform at the intersection of academia, governmental institutions and industry.

Proudly holding its international status, the Conference POLITEHNIKA 2025 encompasses 10 thematic domains: Environment and Sustainable Development, Occupational Safety and Health and Fire Safety, Smart Management Systems, Graphic Engineering, Design, Traffic Engineering, Biotechnology, Pharmacy and Healthcare, Mechanical Engineering, Ecotourism and Rural development, and Mechatronics. By engaging experts, emerging professionals, and practitioners from these domains, the conference unifies fields of study programs of the Academy of Applied Studies Polytechnic. The thematic scopes, coupled with the structure of the compiled papers in this Proceedings, exhibit a rich diversity and multidisciplinary approach, fundamentally contributing to a holistic examination and resolution of societal and scientific challenges.

Comprising over 200 peer-reviewed contributions, the Proceedings represent a substantial intellectual asset, aligning with the conference's overarching objective of fostering the exchange of knowledge, research findings, and professional experiences among experts from industry, research institutions, and higher education establishments.

The Proceedings of the International Scientific and Professional Conference POLITEHNIKA 2025 serve as a comprehensive snapshot of the current landscape within the thematic realms of the conference, offering both insights and directives for ongoing scientific and professional development. Moreover, it offers concrete solutions to practical challenges grounded in contemporary trends and pertinent insights.

The Academy of Applied Studies Polytechnic extends its sincere appreciation to all conference supporters whose financial contributions played a pivotal role in its successful realization. Special acknowledgment is reserved for the authors of the papers, whose diligence and eagerness to present their work to a wider audience, alongside the reviewers and members of the International Scientific Committee, Program Committee and Organizational Committee, have collectively contributed to the triumph of the International Scientific and Professional Conference POLITEHNIKA 2025.

Belgrade, November 2025
EDITORS



TABLE OF CONTENTS

SCOPE 1. ENVIRONMENT AND SUSTAINABLE DEVELOPMENT

Srećko Stopić, Zixi Gao, Hanwen Chung, Bernd Friedrich, Mulbah Forkpayea, Duško Kostić, Nenad Nikolić, Vladimir Damjanović, Dragana Životić <i>The importance of using hydrometallurgical treatment of different raw materials at high pressures for environmental protection and sustainable development</i>	25
Dorđe Ogrizović, Milica Delić, Maja Đolić, Ivana Matić Bujagić <i>Recent advances in removal of emerging contaminants from wastewaters</i>	31
Ljiljana Tolić Stojadinović, Radmila Novaković, Dušan Kekić, Ina Gajić, Svetlana Grujić <i>Determination of selected antibiotics in hospital and urban wastewater using liquid chromatography-tandem mass spectrometry</i>	36
Natalija Nedić, Tamara Tadić, Sandra Bulatović, Bojana Marković, Aleksandra Nastasović <i>Optimization of orange G sorption using GMA-based polymer through response surface methodology and Box-Behnken design</i>	42
Natalija Nedić, Tamara Tadić, Sandra Bulatović, Aleksandra Nastasović, Bojana Marković <i>Efficient removal of aniline from aqueous solution using a hydroxyl methacrylate-based sorbent</i>	47
Jelena Vesković, Milica Lučić, Andrijana Miletić, Marija Vesković, Antonije Onjia <i>Identifying groundwater heavy metal(loid) pollution sources in the Požarevac area using principal component analysis</i>	52
Nataša Palić, Marina Maletić, Ana Kalijadis, Anita Lazić, Katarina Trivunac, Marija Vukčević <i>Comparative analysis of chemically and thermally modified potato starch for the adsorption of brilliant green dye</i>	57
Tijana Radojičić, Nataša Palić, Marina Maletić, Nataša Mladenović Nikolić, Daniela Popović, Marija Vukčević, Katarina Trivunac <i>Alkali-activated material: A sustainable approach for adsorbing heavy metals and rare earth elements from water</i>	63
Miodrag Stanisavljević, Ana Stojković, Ivan Krstić <i>Comparative analysis of conventional and non-conventional systems for electroplating wastewater treatment</i>	69
Marija Vesković, Jelena Vesković, Antonije Onjia <i>Hydrogeochemical characterization of groundwater in the Northeastern Serbia</i>	75
Dragana Popović, Jovana Savanović, Andrija Vučetić, Tatjana Ćurčić, Dragana Despot <i>Optimization of solid-phase extraction for the determination of quaternary ammonium compounds in water by UHPLC–MS/MS</i>	80
Tijana Spasojević, Marina Maletić, Ana Kalijadis, Nataša Mladenović, Katarina Trivunac, Marija Vukčević <i>Carbonization and activation of flax fibers for the removal of bromazepam from water</i>	85
Tijana Spasojević, Marina Maletić, Dušan Trajković, Isabel Gria, Mirjana Ćujić, Nevena Prlainović, Maja Đolić <i>Enhanced arsenic removal using an iron-modified sandy clay and biochar</i>	91
Andrijana Miletić, Jelena Vesković, Milica Lučić, Antonije Onjia <i>Chemometric analysis of trace elements in sediments near an industrial ship dock</i>	97
Grozdana Bogdanović, Dragan Radulović, Dragana Marilović, Jovica Stojanović, Sanja Petrović, Vladimir Simić <i>From waste to resource: Leaching metals from flotation tailings at the “Rudnik” mine for sustainable development</i>	103

Anja Bubik, Klara Hohkraut <i>From isolation to detection of microplastics in natural and industrially processed honey</i>	107
Milica Vlahović, Miljan Vlahović, Nenad Vušović, Darja Žarković <i>Radium contamination of groundwater and remediation approaches</i>	113
Marija Prosheva, Teodora Stojanovska, Andrea Petanova, Jadranka Blazhevskia Gilev <i>Degradation behavior of lignin/TiO₂ waterborne polymers</i>	119
Dorđe Ogrizović, Milica Delić, Ivana Matić Bujagić, Maja Đolić <i>Adaptive water management and pathways toward urban resilience</i>	125
Andrea Petanova, Marija Prosheva, Jadranka Blazhevskia Gilev <i>Towards sustainable carbon nanomaterials: Pulsed laser-assisted synthesis approach</i>	130
Milica Rančić, Jelena Gržetić, Tamara Tešić, Ivana Gavrilović-Grmuša <i>Development and applications of bioepoxies for green materials</i>	136
Milica Rančić, Mladen Popović, Ivana Gavrilović-Grmuša <i>Green innovation in materials: Eco-panels made from hemp shives and starch</i>	142
Nevena Purić, Marija Popović, Darko Đorđević, Maja Đolić <i>Biowaste as a resource: Challenges and opportunities for biowaste management and sustainable infrastructure in Serbia</i>	147
Jelena Gligorijević-Sokolović, Vesna Krstić, Ana Petrović, Zoran Štirbanović, Jovica Sokolović <i>The role of solid recovered fuel (SRF) in waste reduction, resource management and carbon footprint mitigation within the circular economy</i>	153
Darja Žarković, Ana Aleksić, Milica Vlahović, Nenad Vušović <i>Information technologies in municipal solid waste management – from public participation to powerful software tools</i>	159
Darja Žarković, Milica Vlahović, Žaklina Todorović, Miljan Vlahović, Milica Prelić <i>Application of information systems in water resources monitoring and management</i>	165
Vesna Alivojvodić, Niko Samec, Filip Kokalj <i>Standards-based value creation for modern waste-to-energy facilities</i>	171
Vesna Alivojvodić, Aleksandra Vučinić, Nela Vujović <i>Bridging policy gaps through ISO 59000 standards in European waste management transitions</i>	177
Lea Komerički Kotnik, Katrin Školnik Škrabe, Anja Bubik <i>Erasmus+ projects as the opportunity to improve youth awareness on microplastics</i>	183
Nataša Radić, Andreja Stojić, Mirjana Perišić <i>Analysis of the effects of social and industrial changes on air quality during the Covid-19 pandemic in Belgrade</i>	189
Jasmina Bašić, Dragana Dragaš Milovanović, Mila Filipović, Marina Ivanović, Bojana Luković, Danijela Pecarski <i>Air pollutant levels in the first half of 2025 and their health effects in the Republic of Serbia</i>	195
Aleksandar Petković, Jovan Ilić <i>Numerical simulations of transient operation of SHPPs with pelton turbines and selection of protective measures. Case study of SHPP Velika Ploca</i>	202
Slavica Mihajlović, Nataša Đorđević, Vladan Kašić, Srđan Matijašević <i>The significance of the circular economy in solid waste management</i>	208
Jelena Andrić <i>Towards sustainable development in infrastructure projects</i>	214
Nataša Radić, Ana Popović, Vesna Alivojvodić <i>Practices and attitudes toward food waste in the Republic of Serbia - pilot survey</i>	219
Radule Tošović <i>Managerial-economic aspects of the participation of environmental costs in the cost price of mineral raw materials in the mineral sector</i>	224
Ana Popović, Nebojša Ćurčić, Aleksandra Božić <i>Managing environmental disasters: The role of environmental risk assessment</i>	230

Miloš Tošović <i>Copenhagen school of security in the light of analysis of environmental security and environmental risk management</i>	236
Suzana Radojković <i>Microbiological pollution in the Toplica River: Impact and Solutions</i>	242
Tatjana Mitrović, Marija Perović, Darija Obradović, Saša Lazović <i>Soil remediation: Perspectives and risks</i>	248
Tatjana Mitrović, Marija Perović, Darija Obradović, Saša Lazović <i>Ecological risks of urban soils in Belgrade</i>	254
Aleksandra Pavlović, Andrea Ivanišević <i>Is Serbia becoming a pollution haven? The impact of FDI on air pollution and public health</i>	260
Dragan Ugrinov, Magdalena Nikolić <i>A model of successful medical waste management in Pančevo municipality – system analysis and development perspectives</i>	266
Dragan Ugrinov, Magdalena Nikolić <i>Ecological and political dimensions of sustainable natural resource management in the context of climate change</i>	271
Magdalena Nikolić, Dragan Ugrinov <i>Ecotourism as a mechanism for biodiversity conservation in the protected natural areas of Serbia</i>	277
Marija Tasić, Milica Petković, Sofija Miljković, Žarko Vranjanac <i>Application of the Serbian water quality index in the assessment of the Jerma, Gaberska River, and Great Timok (2019–2023)</i>	283
Aleksandar Petković, Jovan Ilić <i>Numerical simulations of long-term annual energy generation of SHPP Kresaja</i>	289
Zorica Baroš, Olivera Jovanović <i>Monitoring ionizing radiation in the Republic of Serbia</i>	293
Sara Stanić Jovanović, Marica Milošević, Ana Urošević, Božo Ilić <i>The importance of environmental sustainability in hotel operations: A case study of Hotel 'Iver'</i>	299
Jovana Vukanić, Bojana Sterniša Stanišić <i>Urban ecology in architecture: Ecological potential of public spaces and strategies for improving biodiversity</i>	306
Vaishnavi Khedulkar, Ana Popović <i>The evolution of sustainability: From cultural roots to future generations</i>	312
Ivana Rvović, Aleksandra Davidović <i>Forest fires in Serbia – spatial analysis of the impact of forest ownership and prevention measures</i>	317
Bensedira Noureddine, Milles Abdessmad, Aggoune Mohammed-Salah <i>Photovoltaic supplied MHD desalination system for agricultural uses</i>	323
Nevenka Galečić, Đurđa Petrov, Dejan Skočajić, Jelena Čukanović, Sara Đorđević, Radenka Kolarov, Mirjana Ocokoljić <i>The influence of light and air temperature on the visual perception of Photinia x fraseri 'Red Robin' in the parterre composition of Savski Square in Belgrade</i>	329
Đurđa Petrov, Nevenka Galečić, Dejan Skočajić, Jelena Čukanović, Dragan Vujičić, Sara Đorđević, Mirjana Ocokoljić <i>Secondary flowering and fruiting of Laburnum anagyroides Medik. and their importance in urban landscape design</i>	335
Mirjana Ocokoljić, Jelena Čukanović, Sara Đorđević, Nevenka Galečić, Dejan Skočajić, Radenka Kolarov, Đurđa Petrov <i>Amorpha fruticosa L. in the alluvial habitats of Belgrade and Novi Sad: Morphological and phenological characteristics of inflorescences, flowers, and flowering in the context of ecosystem service</i>	341

Nevenka Galečić, Đurđa Petrov, Dejan Skočajić, Jelena Čukanović, Radenka Kolarov, Sara Đorđević Mirjana Ocokoljić <i>Adaptation of flowering phenology and flower longevity of <i>Philadelphus coronarius</i> L. in landscape design under climate change conditions</i>	347
Mirjana Ocokoljić, Nevenka Galečić, Dejan Skočajić, Jelena Čukanović, Sara Đorđević, Radenka Kolarov, Đurđa Petrov <i>Viburnum tinus</i> L.: Mediterranean floral element in the urban and suburban landscape of Belgrade	353
Mirjana Ocokoljić, Radenka Kolarov, Jelena Čukanović, Nevenka Galečić, Dejan Skočajić, Sara Đorđević, Đurđa Petrov <i>Morphological and biochemical characteristics of the fruits of <i>Malus hupehensis</i> var. <i>Pinyensis</i> n.g. Jiang in Belgrade</i>	359
Đurđa Petrov, Nevenka Galečić, Dejan Skočajić, Jelena Čukanović, Dragan Vujičić, Radenka Kolarov, Mirjana Ocokoljić <i>Punica granatum</i> L. in garden design in Serbia	365
Mirjana Ocokoljić, Nevenka Galečić, Jelena Čukanović, Sara Đorđević, Radenka Kolarov, Đurđa Petrov <i>Ornamental cherry trees in the open urban spaces in front of the temple of Saint Sava in Belgrade: Identification and significance</i>	372

STUDENT PAPERS

Nikola Stojković <i>Determination of heavy metal content in river fish</i>	378
Marija Perkunić, Ana Popović <i>Integrating phytoremediation into sustainable development strategies: Lead removal potential of <i>Mentha</i> sp.</i>	384
Nikola Stojković <i>Digital ecology and the environmental impact of digital platforms</i>	390
Lav Leskur <i>Environmental risk assessment for Pambukovica Dam project in Serbia – a case study</i>	395

SCOPE 2. OCCUPATIONAL HEALTH AND SAFETY AND FIRE SAFETY

Dragan Jovanović <i>The role of experts in court proceedings of the Republic of Serbia</i>	402
Jelena Andrić, Xi'an Jiaotong <i>The analysis of occupational accidents on construction sites in Hong Kong</i>	408
Branka Bursać Vranješ, Svetozar Sofijanić <i>Specific features of occupational safety and health organization in bridge construction</i>	413
Dragan Živanić, Nikola Ilanković, Tanasije Jojić <i>Integration of sensor systems for enhancing escalator safety and reliability</i>	419
Dragan Živanić, Nikola Ilanković, Tanasije Jojić <i>Design and analysis of a conveyor system for removing floating waste from river surfaces</i>	425
Marko Miletić, Aleksandar Pantović, Marko Milošević, Marko Đapan, Ivan Mačužić <i>The improvement of lockout/tagout compliance in manufacturing through digitalization</i>	431
Daniela Ristić, Ognjen Ristić <i>The impact of work stress on employees' performance and job satisfaction</i>	437

Snežana Knežević, Snežana Milanović, Marijana Jandrić Kočić, Tamara Gajić <i>Work-life balance among higher education employees</i>	442
Maja Đikić <i>From paper to practice: How employees use personal protective equipment and perceive occupational health and safety training</i>	448
Nebojša Ćurčić, Novak Milošević <i>Real-time monitoring of workplace environmental factors using smart devices – an overview on vibration exposure evaluation</i>	454
Darko Marković, Nebojša Ćurčić, Novak Milošević <i>Research on impact of cultural diversity on occupational safety and health culture in multinationals teams based on Hofstede's cultural dimensions theory</i>	461
Dejan Kožović, Dragan Đurđević, Mirko Dinulović, Marta Trninić <i>ADS-B aviation system: Analysis of real time flight data</i>	470
Nataša Ćirović, Nebojša Bošnjaković <i>Fire risk level of a residential business object</i>	476
Petar Simonović, Marijola Božović <i>Training fires as high-risk events: Rethinking safety in simulated environments</i>	484
Ana Aleksić, Darja Žarković <i>Application of GIS technology in the education of engineers of fire protection</i>	490
Nikola Tanasić, Radenko Rajić, Ivan Arandjelović <i>A novel tabular method for estimation of heat extraction factor</i>	496
Milivoje Filipović, Marina Milovanović Arandjelović <i>An extended tabular method for estimation of water flow rate at the hydrant nozzle</i>	500
Barbara Vidaković Ristić <i>Understanding intentional fires: From 'how' to 'why' through an interdisciplinary lens</i>	504
Barbara Vidaković Ristić <i>Fire risk management in nightclubs: Regulatory framework, practice and recommendations</i>	509

STUDENT PAPER

Lav Leskur <i>How to prevent workplace accidents and save workers' lives? Tackling the invisible trio of depression, anxiety and insomnia before it's too late</i>	515
--	------------

SCOPE 3. SMART MANAGEMENT SYSTEMS

Dragana Gardašević, Koviljka Banjević, Milanka Gardašević-Filipović, Vladan Radivojević <i>AHP and PROMETHEE II methods in selecting candidate for the position of strategic planning manager</i>	522
Brankica Pažun, Zlatko Langović, Milena Cvjetković <i>Quantum computing in business decision-making</i>	528
Dragana Gardašević, Aleksandra Božić, Ana Popović, Vladana Ilijin <i>Application of control charts in the internal control of chemical oxygen demand determination method</i>	535
Dušan Trajković, Nevena Purić, Aleksandar Kojović, Dragana Živojinović <i>Global market and standardization in biofuel industry</i>	540
Saša Marković, Marko Pavlović <i>Possibilities of improving business processes and business efficiency in the automotive industry</i>	546

Dragana Rošulj, Aleksandra Nastasić, Dejan Petrović <i>The culture of knowledge management and its impact on the implementation of knowledge management processes</i>	552
Biljana Ljubanović, Koviljka Banjević, Zoran Sekulić <i>Change scenario: Control of documented information</i>	559
Goran Nestorović <i>Development of teaching staff through the introduction of professional doctoral studies</i>	565
Predrag Janković, Dragan Miletić, Suzana Pavlović <i>The place and perspectives of the development of dual education in the higher education the Republic of Serbia</i>	572
Vana Colić <i>The role of mathematical education and digital competencies in preparing workforce for Industry 4.0</i>	578
Ivan Mačužić, Marko Milošević, Nikola Tonić, Marija Savković, Đorđe Milojević <i>Demo-didactic systems for practical training in Industry 4.0</i>	583
Đorđe Dihovični, Dragan Kreculj, Nada Ratković Kovačević, Goran Vorotović <i>XML approach to the creation of a database for the alumni project</i>	589
Goran Vojnović <i>Augmented reality in academic libraries: Implementing affordable tools</i>	594
Marija Mićanović <i>The analysis of writing style and the application of tools for academic writing</i>	600
Aleksandra Nastasić, Dragana Rošulj, Aleksandra Božović <i>Influence of artificial intelligence on organisational culture</i>	606
Marija Simonović, Snežana Tadić, Mladen Krstić, Miloš Veljović <i>Space logistics: How to get into space?</i>	612
Saša Marković, Marko Pavlović <i>Strategic forms of business internationalization</i>	618
Bosiljka Srebro, Marija Perić, Stevica Dedanski <i>The impact of digital technologies on enterprise e-commerce export strategies</i>	623
Jasmina Đurašković, Ana Slavković, Brankica Pažun <i>Web transparency of CSR activities in Belgrade municipalities: A content analysis of official websites</i>	629
Aleksandra Pavlović <i>Economic growth in Serbia - Does inflation matter?</i>	634
Brankica Pažun, Zlatko Langović, Jasmina Đurašković <i>Processor technologies and their impact on global economic trends</i>	639
Srdan Barzut, Dragana Sajfert, Ana Bašić, Milica Jevremović <i>The main cyber treats in modern e-business</i>	643
Marko Pavlović, Dragana Đurić, Miloš Lučić <i>The role of CRM systems in the revitalization of an artistic brand: A study on consumer perception of the Naslikati brand</i>	650
Đorđe Dihovični <i>Programs and their applications in web design and web management</i>	656

STUDENT PAPER

Lav Leskur <i>Is personality the missing key for boosting sales? A fresh perspective for marketing strategists on Serbian consumers' organic food attitudes</i>	662
---	------------

SCOPE 4. GRAPHIC ENGINEERING

- Adrijana Đorđević, Danijela Kovačević, Nenad Đorđević, Aleksandra Krstić** 669
An investigation into the mechanical properties of corrugated fiberboard packaging boxes
- Dejan Miljković, Danijela Kovačević, Adrijana Đorđević, Nenad Đorđević, Aleksandra Krstić** 675
Comparative analysis of transport packaging manufactured using flat and rotary die-cutting tools

SCOPE 5. DESIGN

- Predrag Maksić** 682
Foundations and principles of interdisciplinary design: Towards a holistic approach to creative practice
- Ljubomir Maširević** 688
The video game industry and globalization
- Ljubomir Maširević** 694
Video games in culture
- Duška Komnenić** 701
AI and the aesthetic of imperfection: Defining the visual signature of machine-made art
- Danica Glođović** 705
Visual codes and cultural narratives: Rethinking graphic design as semiotics
- El Hadj Mimoune Arezki, Khattabi Lahcene, Berkani Dalila** 710
Eternal geometry: Zellij as a bridge between Islamic heritage and modern design
- Maja Milinić Bogdanović** 716
How additive manufacturing can enhance contemporary fashion and footwear design
- Jelena Zdravković** 723
Contemporary fashion and interdisciplinary approach to design: Zero waste fashion design
- Jelena Zdravković, Igor Ponti** 730
Fashion design and digital technology: Ready-to-wear collections and the modern textile industry in Serbia
- Jasna Jelić Obradović** 738
The influence of art theory in the field of design
- Željko Zdravković** 743
Designing the future: How AI platforms are transforming industrial design in our world today
- Duško Radaković, Nebojša Andrijević, Dragana Gardašević, Nenad Živanović** 750
An assessment of diverse generative AI applications
- Duško Radaković, Danijela Živojinović** 757
Implicit modeling and the future of next gen CAD
- Fedor Rakić** 765
Will artificial intelligence ever replace the UX designer?
- Fedor Rakić** 770
Real vs. synthetic users: The future of UX testing
- Dragica Nikodinović** 776
Poster design in the society of the spectacle
- Jelena Jocić, Maja Milinić Bogdanović** 782
Contemporary creative approaches and technological tendencies in graphic art and fashion design communication

Katarina Nikolić <i>Oblique strategies and projector cards – fostering creativity in design through randomness and material engagement</i>	788
Natalija Đukić <i>Space as the third teacher: Architecture of preschool institutions based on the Reggio Emilia approach – case study analysis</i>	795
Dejan Vračarević <i>The Future of 3D additive technologies in an artificial intelligence environment for industrial designers and artists</i>	801
Milica Matović <i>Digital aesthetics and contemporary painting: The transformations of visual form in post-media art</i>	805
Duško Trifunović <i>Werner Jeker — photography, typography, and grid in poster design</i>	811
Sandra DePalo <i>The colour of light: Influence of James Turrell's work on contemporary interior lighting design</i>	816
Sandra DePalo <i>Light narratives: Adaptive museum lighting as a medium of artistic expression and communication</i>	823
Natalija Gaković <i>Selection of contemporary synthetic polymeric organic materials for application in sustainable interior design</i>	830
Jelena Ivanović Vojvodić, Goran Vojvodić <i>Reconstruction of the Building Palace of Science in Belgrade – The Miodrag Kostić Foundation Endowment</i>	836
Ivan Erkić <i>The power of the new 3D material in visual merchandising</i>	842

SCOPE 6. TRAFFIC ENGINEERING

Biljana Ranković Plazinić, Željko Ranković, Nemanja Deretić <i>A methodology to determine parking zone boundaries</i>	848
Nebojša Andrijević, Zoran Lovreković, Bojan Jovanović, Vlada Jevtić, Branko Petrović <i>IoTarchitecture for a smart modular traffic intersection control with real-time multi-sensor adaptation</i>	854
Dejan Jovanov, Daniel Pavleski, Kosta Jovanov <i>Road safety action plan: Data driven decision making approach</i>	862
Željko Ranković, Biljana Ranković Plazinić, Nemanja Deretić <i>Comparison of road safety level on the “Miloš Veliki” motorway and two-lane state road IB No. 22 following the construction of the “Miloš Veliki” motorway</i>	868
David Rilak, Boris Antić, Nenad Marković, Emir Smailović <i>Identification of characteristic road problems and deficiencies at locations, sections, and streets of increased pedestrian risk in the territory of the Belgrade police department, through the application of independent assessment</i>	874
Denis Lukač, Mirsad Velju, Jasmin Hodžić <i>Analysis of traffic safety at level crossings in Montenegro</i>	880
Aleksandra Obradović, Biljana Ranković Plazinić <i>The impact of signalization of pedestrian crossings on pedestrian safety</i>	886
Jaime Vite Solares, Iran Guerrero Andrade <i>Pedestrian mobility and urban policy in Pachuca: Inequality, risks, and the right to the city</i>	893

Dragana Velimirović, Milan Marković, Milan Velimirović <i>Novelties in automotive industry sector in European countries</i>	899
Danijela Miloradović, Jasna Glišović, Jovanka Lukić <i>Measuring instruments for vehicle technical inspection in technical regulations – a review</i>	905
Dobrivoje Ćatić, Vladimir Ćatić <i>Analysis of brake drum damage in motor vehicle braking systems</i>	911
Nemanja Deretić, Saša Kukolj <i>Human resource management and digital transformation in transport companies</i>	917
Slavka Durlević <i>The role of logistics center in the supply chain – a case study</i>	923
Filip Marković, Miroljub Nikolić, Maja Stošković <i>Financial aspects of supply chain optimization in freight forwarding</i>	929

SCOPE 7. BIOTECHNOLOGY, PHARMACY AND HEALTHCARE

Dragana Ilić Udovičić, Jelena Đuričić Milanković, Aleksandra Vasić Popović, Ivana Jevtić, Jelena Makević <i>Allergens as a parameter of food quality and safety control: Attitudes and awareness of medical school students</i>	935
Dubravka Mandušić <i>Artificial intelligence in the animal world</i>	941
Tatjana Marinković, Dragan Marinković, Jovana Pavlović <i>Physical activity and microbiota: An overlooked link to health</i>	945
Snežana Knežević, Snežana Milanović, Slavica Đorđević, Marijana Jandrić Kočić <i>Preventive medicine and healthy aging: Addressing population frailty prevention</i>	951
Snežana Knežević, Aleksandar Stevanović, Snežana Milanović, Slavica Đorđević <i>Climate change impacts on bacterial foodborne infections and food safety</i>	957
Tanja Krunić <i>Reusing and improving food industry waste</i>	963
Višnja Sikimić, Slavica Čabrilo, Nada Jelić <i>Formulations of gluten free biscuits with improved nutritional and functional properties</i>	969
Marina Ivanović, Jasmina Bašić, Mila Filipović, Dragana Dragaš Milovanović, Bojana Luković <i>Utilization of lactic acid bacteria in food technology from bioprotection to sensory quality enhancement</i>	977
Dragana Dragaš Milovanović, Jasmina Bašić, Mila Filipović, Marina Ivanović, Bojana Luković <i>Dose-response relationship between chronic exposure to trihalomethanes and haloacetic acids and adverse health outcomes</i>	982
Dragana Dragaš, Jasmina Bašić, Danijela Pecarski <i>Current pharmacogenetics trends in depression treatment</i>	985
Nebojša Andrijević, Zoran Lovreković, Vladan Radivojević, Mihajlo Manojlović, Milica Velkovski <i>Implementation of IoT systems in modern agriculture: Optimization and automation of smart greenhouse functionality</i>	989
Miloš Purić <i>Apricot kernel oil as a new edible products processed from biowaste</i>	996

Eleonora Gvozdić, Danijela Prokić, Marija Bajović, Svetlana Grujić, Tatjana Đurkić <i>Fungicide residues in apples: Analysis and health risk assessment</i>	1002
Marija Bajović, Eleonora Gvozdić, Tatjana Đurkić <i>Validation of a GC-MS/MS method for determining 200 pesticides in herbal tea infusions</i>	1008
Milica Jevtić, Goran Nestorović, Darko Stojićević <i>The rise of data-driven agriculture: Transforming farming through digital intelligence</i>	1013
Vladanka Stupar, Milica Jevtić <i>Sustainable innovation in plant production</i>	1018
Melita Zec Vojinović, Kristijan Jurišić, Slavica Dudaš, Martina Peršić, Marin Tomičić <i>The inhibitory potential of thyme essential oil (<i>Thymus vulgaris</i> L. against the phytopathogenic fungus <i>Colletotrichum acutatum</i></i>	1024
Milica Lučić, Andrijana Miletić, Jelena Vesković, Antonije Onjia <i>LC-MS/MS analysis of imazalil in lemons</i>	1030
Ana-Marija Valland, Tatjana Golubović <i>Exposure to antineoplastic pharmaceuticals and associated health effects</i>	1036
Tatjana Sekulić, Vladanka Stupar, Zlata Živković, Milica Blažić <i>Microbial bioremediation strategies of environmental pollutants</i>	1041
Slavica Čabrilo, Višnja Sikimić, Nada Jelić <i>The role of antimicrobial packaging in the protection cheese</i>	1047
Milica Ivanović, Predrag Rajković, Aleksandra Janković, Sandra Stanković <i>Optimization of the mixture composition and initial process parameters for composting grape pomace and co-substrates: Selection of an appropriate method</i>	1054
Markola Saulić, Aleksandar Stevanović, Marko Kovačević, Snežana Knežević <i>Integrated digital systems in pesticide control for safe food and agroecosystem conservation</i>	1061
Tanja Krunic <i>Impact of carrier composition and gastrointestinal digestion on the hydrogel sphericity and diameter</i>	1067
Danijela Pecarski, Dragana Dragaš Milovanović, Jasmina Bašić <i>Mycotoxin contamination in Serbia: Health implications and food safety challenges</i>	1073
Jasmina Rajić, Tanja Petrović, Aleksandra Stojićević, Dragana Mihajlović <i>Functional food: Concept, regulation, and public health significance</i>	1079
Jasna Savić, Aleksandra Božić, Dominik Brkić, Biljana Simić Polić <i>HDL functionality as a biomarker and therapeutic target in the era of new dyslipidemic drugs – a biochemical perspective</i>	1085
Maja Antanasković <i>Treatment and management of medical waste in the Health Center Prokuplje</i>	1092
Jasmina Rajić, Tanja Petrović, Aleksandra Stojićević, Dragana Mihajlović <i>Technological challenges and innovations in the formulation of functional food products</i>	1098
Aleksandra Stojićević, Ana Alimpić Aradski, Smiljana Janković, Jasmina Rajić, Marko Jauković, Aleksandar Stevanović, Milica Blažić <i>The essential oil of <i>Satureja</i> species as a promising food ingredient</i>	1103

STUDENT PAPER

Tijana Pavlović, Aleksandra Stojićević, Marko Jauković <i>Influence of the storage conditions on the chemical composition and shelf life of potato tuber</i>	1109
--	-------------

SCOPE 8. MECHANICAL ENGINEERING

Kuznetsov Yu. A., Yakovlev D.D., Dobychin A.V., Gribakin A.A., Pichev V.S., Kravchenko I. N., Kalashnikova L.V. <i>Formation of protective coatings by high-velocity oxygen-fuel spraying</i>	1115
Milica Timotijević, Olivera Erić Cekić, Petar Janjatović, Stojko Biočanin, Dragan Rajnović <i>Quantification of niobium-rich and chromium-rich carbides in HP40Nb alloy after overheating</i>	1120
Manuel Vite-Torres, Juan Laguna-Camacho, Ezequiel Gallardo-Hernández, Javier Frias-Flores <i>The contribution on solid particle erosion (SPE) of two tribology labs in Mexico</i>	1129
Do Duc Trung, Hoang Tien Dung, Siniša Škrbić, Aleksandar Ašonja <i>Applying the depart method for material selection in mechanical engineering</i>	1135
Aleksandar Cvetković, Žaklina Tasić, Marija Petrović Mihajlović, Milan Radovanović, Ana Simonović, Milan Antonijević, Snežana Milić <i>Carbon paste electrodes and ZnO/CPE sensors: A short review</i>	1141
Đorđe Đurđević, Nikola Tanasić, Andrijana Đurđević, Nina Anđelić <i>Static calculation of smoke exhaust duct construction in fire conditions using FEM</i>	1147
Milan Marković, Dragana Velimirović <i>Moment of inertia as a cause of loss of stability in a front forklift</i>	1153
Bojan Ivljanin, Uroš Kovačević, Vladeta Milenković <i>Comparative analysis of new systems for determining ratio and phase displacement errors on high-voltage current transformers without power interruption</i>	1160
Goran Pavlović, Mile Savković, Nebojša Zdravković, Marko Todorović, Goran Marković, Predrag Mladenović <i>Weight minimization of the hydraulic press frame with metaheuristic algorithms</i>	1166
Andrijana Đurđević, Đorđe Đurđević <i>Static calculation of the tank wall</i>	1172
Strahinja Đurović, Nikolaj Velikinac, Milan Mišić, Aleksandra Kokić Arsić, Goran Maksimović, Ivan Šarkoćević, Andjela Baščarević <i>Artificial intelligence in fused deposition modeling</i>	1177
Milanka Plavšić <i>Design of polymeric materials in function of unit (technological) operations for new industrial production methods</i>	1182
Predrag Drobniak, Đorđe Đurđević, Andrijana Đurđević <i>Analysis of the problem of deformation of the guides and rearing of the guide console from the wall of the passenger lift drive shaft</i>	1188
Miloš Milovančević, Marija Stevanović <i>ANFIS-based prediction of surface roughness and material removal rate in plasma arc cutting of Quard-400</i>	1193
Obrad Aničić <i>Integration of modern technologies and artificial intelligence into CNC manufacturing systems: From 3D modeling to the application of neural networks</i>	1200
Milan Milutinović, Nikola Matić, Uroš Ugrinić <i>Tool life of CBN cutting inserts during hard turning of 60WCrV7 steel</i>	1204
Milan Mišić, Nikolaj Velikinac, Strahinja Đurović, Dragan Lazarević, Bojan Stojčević, Martina Petković, Aleksandra Kokić Arsić <i>Influence of feed rate on surface roughness of 3D printed PLA parts after milling process</i>	1210

Nada Ratković Kovačević, Miloš Jakovljević, Đorđe Dihovični, Milica Ivanović, Petar Jakovljević <i>Project based learning - building a scaled operating CNC mill model using 3D printed parts</i>	1215
Milan Vasić, Mirko Blagojević, Milan Banić, Miloš Josimović, Goran Nestorović <i>Investigation of the influence of lubricant type on the efficiency of a cycloidal reducer</i>	1221
Nataša Soldat, Ivana Atanasovska <i>Step-by-step approach of rolling bearings modelling for efficient FEA contact analysis</i>	1227
Marko Tasić, Žarko Mišković, Radivoje Mitrović <i>Appliance of the polymer material for construction of the conveyor belt carrying idler's shell</i>	1233
Marko Milošević, Dragan Džunić, Živana Jovanović Pešić, Marko Miletić, Vladimir Kočović, Slobodan Mitrović <i>Tribo-mechanical characterization of epoxy-based composites reinforced with abaca fibers: A scratch test study</i>	1239
Milanka Plavšić <i>Some applications of polymer system scaling theory in design of processing industrial equipment</i>	1246
Blanka Škipina, Biljana Pećanin, Aleksandar Savić, Ljiljana Topalić-Trivunović, Branka Ružičić, Slavica Maletić, Mitja Kolar, Manja Kurečić, Andreja Rudolf, Dragana Grujić <i>Enhancing electrical conductivity of polypropylene nonwoven textiles via Cu/Zn-modified bentonite: FTIR, XRD and dielectric study</i>	1252
Milica Timotijević, Stojko Biočanin, Željko Bulatović <i>Reliability model of the CNC hydraulic press DAGGT</i>	1257
Đorđe Karić, Mirko Komatina, Goran Vorotović <i>Machine learning methods for predicting energy savings in building retrofits</i>	1266
Andela Vasović, Nebojša Denić, Nikolaj Velikinac, Aleksandar Marković, Marko Smilić <i>The impact of batch size on the performance of the ResNet-18 model on the CIFAR-10 dataset</i>	1271
Nebojša Petrović, Goran Vorotović, Aleksandar Bengin, Miloš Januzović, Jela Burazer, Dejan Blagojević <i>High-resolution UAV analysis of urban heat islands</i>	1275
Milan Travica, Danilo Miljković, Nenad Mitrović <i>Application of a mobile digital image correlation system for on-site structural integrity assessment</i>	1281
Marija Stevanović, Miloš Milovančević <i>Identification of key influential parameters for economic optimization of wastewater treatment systems using ANFIS</i>	1286
Ioannis Filippou Kyriakidis, Savvas Koltsakidis, Konstantinos Tsongas, Michel Theodor Mansour, Apostolos Korlos, Konstantinos David, Dimitrios Tzetzis <i>Mechanical and dynamic behaviour of thermoplastic polyurethane-based composites produced via fused filament fabrication for machine mount applications</i>	1294

SCOPE 9. ECOTOURISM AND RURAL DEVELOPMENT

Radomir Stojanović <i>Tourism destination management in Serbia - selecting new management model</i>	1301
Jelena Anđelković Grašar, Roksana Chowanec, Emilija Nikolić, Marija Jović, Ljubomir Jevtović, Stefan Stančić <i>Green heritage - archaeological parks as living labs for achieving sustainability</i>	1307
Slobodanka Stankov, Radomir Stojanović, Branko Radeljić <i>Digitalisation of cultural heritage and its impact on tourism development in Serbia</i>	1314

Valentina Radoičić, Ivo Županović <i>Assessment of sustainable tourism development in Durmitor National Park</i>	1320
Marko Pavlović, Dragana Đurić, Saša Marković, Marija Perić, Ben Mladenović <i>Belgrade as a tourist brand - opportunities and development strategies</i>	1326
Biljana Ranković Plazinić, Svetlana Lekić <i>Transport accessibility as a driver of rural development</i>	1332
Aleksandar Todorović, Darko Dimitrovski <i>Field trip as educational instrument in rediscovering rurality</i>	1338

SCOPE 10. MECHATRONICS

Goran Zajić, Milan Pavlović, Marija Zajeganović <i>Case study on generating configuration parameters for network devices and computers using generative AI agents</i>	1346
Dorđe Lazarević, Jovan Ćirić <i>Multisensor IoT system for detection and measurement of physical parameters of the work environment</i>	1352
Nebojša Andrijević, Zoran Lovreković, Vladan Radivojević, Milan Milanović, Milica Stojičević <i>Cost-efficient smart building IoT architecture: Integration of Arduino Mega, ESP32 and real-time web control</i>	1358
Aleksa Turudić, Siniša Škrbić, Uroš Ilić <i>Impact of small distributed energy resources on voltage profiles and power flow in distribution networks</i>	1365
Nikola Slavković, Mirjana Tomić, Dejan Đukic, Goran Zajić <i>Human - machine interrelationship: Automatic sentence generation by rule-based systems</i>	1371
Nastasija Nikolić, Marko Đapan, Ivan Mačuzić, Carlo Caiazzo, Petar Todorović, Arso Vukičević <i>Identification of parameters affecting the implementation of robotic solutions in lean industrial systems</i>	1378
Nada Ratković Kovačević, Goran Vojnović, Đorđe Dihovični, Dragan Kreculj, Petar Jakovljević <i>Programming Arduino to drive a stepper motor for positioning a scanner in a library automation system</i>	1384
Đorđe Dihovični, Aleksandra Mitrović, Nada Ratković Kovačević, Dragan Kreculj <i>Advances in 3D printing of electronics</i>	1390
Nela Vujović, Jelena Zarić Kovačević, Vesna Alivojvodić <i>AI-driven resource efficiency balancing opportunities and constraints in mining</i>	1396
Dragan Kreculj, Đorđe Dihovični, Aleksandra Mitrović, Nada Ratković Kovačević, Miloš Vorkapić <i>Artificial intelligence in digital twins</i>	1401

STUDENT PAPER

Alper Şanlı, Alim Rüstem Aslan, Tuncay Yunus Erkeç, Musa Şen <i>Misalignment effects on optical payload performance for small satellites</i>	1407
--	-------------



MEASURING INSTRUMENTS FOR VEHICLE TECHNICAL INSPECTION IN TECHNICAL REGULATIONS – A REVIEW

Danijela Miloradović¹, Faculty of engineering, University of Kragujevac

Jasna Glišović², Faculty of engineering, University of Kragujevac

Jovanka Lukić³, Faculty of engineering, University of Kragujevac

Abstract: *Technical regulations governing the process of vehicle technical inspections are very important because they ensure that measuring instruments, devices and tools used at technical inspection lines to assess vehicle compliance with traffic safety and environmental requirements (vehicle roadworthiness) are accurate, reliable and standardized. They also ensure that all vehicle technical inspection units use measuring instruments that meet the same performance criteria, so the results are comparable no matter where the inspection is done. This paper reviews some of the most significant international and national regulations on vehicle technical inspections that direct the work of technical inspection units and contain guidelines for selecting the proper type of measuring instruments to meet specific criteria. Special attention is given to Serbian regulations from this field, starting from Road traffic safety law to the specialized rulebooks on measuring instruments at vehicle inspection units. A review of all mentioned regulations has shown that they might become obsolete if they do not take into account rapid changes in vehicle design and general emerging technologies applied to automotive industry. The key to solving this problem may be in continuous harmonization of regulations and close cooperation between regulating bodies, vehicle and equipment producers and licensed technical inspection units.*

Keywords: technical regulations, measurement instruments, vehicle technical inspection

1. INTRODUCTION

Vehicle technical inspections have become a very important component of traffic safety since its introduction in 1920s in the USA and later in Europe. At the initiative of the Motor Vehicle Inspection Committee (CITA) and TÜV SÜD AG, World Health Organization has added the periodical technical inspections (PTI) to the list of main factors in reducing risks of road traffic injuries or fatalities (for the first time in this context) in 2023 [1]. The technical inspection of vehicles is a part of maintaining the vehicle in correct technical state and should be carried out with great accuracy in order to recognize the real technical state of vehicle systems. Frequently, vehicle technical inspection is a combination of professional person's diagnostics and application of technical devices for vehicle technical state diagnostics. Therefore, the technical inspection lines should use modern equipment and devices, but it is also necessary to constantly improve knowledge of the professionals that use certain devices for vehicle technical inspection. Thus, it is necessary to approach this problem with great care and on several levels – from the state bodies that make regulations, through the licensed vehicle technical inspection units and equipment producers, to the owners of the motor vehicles.

Inspecting the motor vehicle's state is done using selected measuring instruments and equipment that make it possible to check physical parameters of individual assemblies and parts of the motor vehicle, which, in case of failure, may cause vehicle malfunction and endanger the safety of traffic

¹neja@kg.ac.rs

²jaca@kg.ac.rs

³lukicj@kg.ac.rs

participants. Measuring instruments and equipment on the technical inspection lines should provide measurement quality and reliability, compliance checkout of vehicle technical state with current regulations, as well as setting the technical inspection on higher technological level. Consequently, all measuring equipment must be kept in good working order and calibrated properly. Requirements for measuring instruments used at vehicle technical inspection lines are set by a number of international and national regulations that ensure safe road traffic flow across different countries.

2. MAJOR TECHNICAL REGULATIONS ON VEHICLE PTI

United Nations Economic Commission for Europe (UNECE) has adopted the vehicle inspection agreement in 1997 - “Agreement concerning the adoption of uniform conditions for period technical inspection of wheeled vehicles and reciprocal recognition of such inspections” [2] and, consequently, its addenda Rules No. 1, 2, 3 and 4 [3-6]. These form the basis for building national regulations concerning aspects of PTI linked to environmental issues, safety inspection, LPG/CNG driven vehicles and electric (EV) and hybrid electric (HEV) vehicles. Recently, draft proposals have been made to adopt the new rule (Rule No. 5) [7] on uniform provisions for periodical technical inspections of accident emergency call systems. Also, there are two linked UNECE documents in the form of resolutions: 1) Resolution R.E.6 [8] that deals with provisions for conducting technical inspections according to the Rules annexed to the 1997 Agreement which states the minimum requirements for technical inspection facilities and test equipment and 2) Mutual Resolution No. 1 (M.R.1) [9] of the 1958 and the 1998 Agreements that deals with test technical inspection tools and devices used according to the technical prescriptions specified in UN Regulations and UN Global Technical Regulations (GTR).

While UNECE regulations do not directly dictate the specific measuring tools for vehicle PTI, they define the required standards for vehicle performance and testing procedures. The instruments and tools used during vehicle PTI must align with these regulations to ensure that the inspections are compliant with global road safety and environmental and technical standards. For 56 countries following UNECE standards, regular calibration and compliance with these regulations are critical to the integrity of the vehicle PTI process. In European Union, vehicle PTI is governed by EU Directive 2014/45/EU [10], as part of 2014 roadworthiness package (RWP). It sets minimum standards for vehicle roadworthiness inspections. Annex III of this Directive contains minimum requirements concerning roadworthiness facilities and test equipment. The measuring instruments that must be used during vehicle PTI are specified to ensure the accuracy and consistency of inspections across member states. These instruments help check various components such as brakes, suspension, steering, emissions, lights, tires, etc. and must be calibrated, maintained and operated in accordance with strict EU regulations. European Commission has adopted annexes to this Directive, adding a “device to measure particle number emissions with sufficient accuracy” to the list of minimum requirements for equipment at vehicle PTI lines in 2025 [11].

Another part of the RWP package is the EU Directive 2014/47/EU that establishes the rules regarding the roadworthiness of commercial vehicles, focusing particularly on the periodic roadworthiness testing and inspection of vehicles and their components. Under this Directive, all EU member states must perform technical roadside inspections using “mobile inspection units” and “designated roadside inspection facilities” that include “appropriate equipment for carrying out a more detailed technical roadside inspection, including the equipment necessary to assess the condition of the brakes and brake efficiency, steering, suspension and nuisance of the vehicle as required” [12].

Newer and more advanced approach to vehicle PTI called “electronic periodic technical inspection” (ePTI) has been developed by ISO Work group TC22/SC31/WG07 (ePTI) with standardized implementation of the electronic vehicle interface functions required for PTI. The results were incorporated into ISO 20730 “Road vehicles - Vehicle interface for electronic Periodic Technical Inspection (ePTI)” standard series [13-15]. These standards state the minimum requirements for ePTI external test equipment that perform assessments, measurements and control of vehicle ePTI-relevant systems. However, it does not directly specify any type of test method or equipment for ePTI.

Activities conducted in order to determine the current and predict the future vehicle technical state are regulated by several legal regulations in the Republic of Serbia. The regulations for vehicle PTI in Serbia align with European Union standards but have some country-specific guidelines. Vehicle technical state and participation in traffic are dealt with: “The road traffic safety law” [16], “The rulebook on registration of motor vehicles and trailers” [17] and “The rulebook on technical inspection of vehicles” [18].

In order for “The road traffic safety law” to be applied in practice, competent ministry had to adopt around 40 rulebooks. These rulebooks refer to: road construction, traffic signal installation, vehicle equipment, rules for vehicle technical inspection and registration, obtaining the driver’s license, etc. Section XVI of the “The law of traffic safety on the road” deals with technical inspection of motor vehicles and trailers. General stipulations prescribe the types of technical inspections (regular, emergency and control vehicle inspections) and conditions that must be met by company in order to carry out the activities of vehicle technical inspection (regarding building with access and exit routs, devices and equipment for conducting the technical inspection, professional staff, information equipment and video recording system). Measuring instruments used for vehicle technical inspection must meet all the conditions prescribed by metrological regulations. Company performing vehicle technical inspection is obliged to immediately stop working in case the device or the equipment used for technical inspection is faulty [16].

“The rulebook on registration of motor vehicles and trailers” states that the vehicle is registered by entering prescribed data in the records – unified vehicle registry, which is kept in the unified information system of the Ministry of internal affairs. Unified vehicle registry contains data on technical inspection (name and address, code, ID number of technical inspection unit, date of technical inspection). Data on technical inspection unit are also a part of the registration unit of motor vehicle or a trailer [17].

“The rulebook on technical inspection of vehicles” prescribes the manner of conducting the technical inspection of the vehicles and the conditions that must be met by companies performing the technical inspection of the vehicles regarding:

- facility, i.e. a testing ground, for performing technical inspections of vehicles, access roads and other traffic surfaces,
- devices and equipment for performing technical inspections of vehicles,
- professional personnel for performing technical inspections of vehicles and
- regulations and technical documentation.

This rulebook prescribes the necessary devices and equipment that are used on technological lines of the technical inspection units and their required characteristics.

3. MEASURING INSTRUMENTS FOR VEHICLE PTI VIEWED FROM THE ASPECT OF TECHNICAL REGULATIONS IN SERBIA

According to “Metrology Act” [19], a measuring instrument is a device used for measurements - alone or in combination with one or more additional devices. Devices for performing technical vehicle inspections that constitute measuring instruments within the meaning of metrological regulations must be certified by the competent authority within the deadlines specified in those regulations, for which there must be appropriate evidence. On the other hand, devices for which there are no prescribed metrological requirements or for which certification is not required must be calibrated by an accredited organization, for which there must be appropriate evidence [18].

A company that performs vehicle technical inspections (licensed technical inspection unit) must have the following measuring devices [18]:

- for measuring braking forces on the circumference of the wheels, meeting special conditions for the technical inspection of different types of vehicles,

- for measuring the smoke density of diesel engine exhaust gases, which works on the principle of measuring the opacity of the smoke column and which allows measuring the engine speed and operating temperature (smoke meter),
- for measuring exhaust gas emissions from engines with active ignition, which allows measuring the CO level, engine operating temperature and engine speed and calculating the air-fuel ratio (λ factor),
- for measuring tire pressure (manometer),
- for checking direction and intensity of headlights (regloscope),
- for measuring moped speed (only for performing technical inspections of mopeds and motorcycles),
- for measuring vehicle deceleration at performing technical inspection at the testing site (decelerometer),
- for measuring the axle load of a vehicle,
- for measuring the moisture content in brake fluid,
- measuring tapes,
- sliding length ruler,
- callipers for checking the device for connecting the towing vehicle and the trailer,
- device for controlling the gap between the wheels and the chassis and the steering mechanism (stretcher),
- duct crane for lifting a single axle of a vehicle,
- device for functional control of the electrical connections of motor vehicles that tow trailers,
- leakage control device of the gas installation of LPG powered vehicle (gas detector),
- compressor with working pressure that corresponds to mass of inspected vehicle,
- device that has the ability to check the correctness of the system for warning about the malfunction of air pollution control equipment via the vehicle's OBD connection and
- device for checking the correctness of the device for stopping trailer vehicles with inertia command.

“Rulebook on types of measuring instruments subject to legal control” [20] prescribes the types of measuring instruments for which certification is mandatory (also in the case when they are used for purpose of traffic control and traffic safety), as well as the time intervals for periodic certification of these measuring instruments. Detailed requirements for some of the above-mentioned PTI measuring devices are regulated by other specialized rulebooks [21-25], with a field of application that includes measuring instruments used for traffic control and safety purposes during vehicle technical inspection on technical inspection lines.

"Rulebook on reglosopes" [21] applies to reglosopes used for traffic control and safety purposes during vehicle technical inspections on technical inspection lines. It prescribes the requirements for the reglosopes, their marking, method for determining whether the requirements have been met, measurement methods and method and conditions for regloscope certification. The requirements for measuring instruments measuring braking force in motor vehicles and trailers, their marking, the method of determining compliance with these requirements, the method of testing the type of measuring instrument, the measurement methods, as well as the method and conditions for their certification are prescribed by “Rulebook on measuring instruments for measuring braking force in motor vehicles” [22]. “Rulebook on manometers for measuring tire pressure” [23] deals with requirements for tire pressure manometers used for traffic control and safety purposes: during vehicle technical inspections at technical inspection lines, when performing tire repair services and at gas stations. It also has sections dedicated to: measuring results units, manometer marking, method of determining whether the requirements have been met and manometer certification.

Opacimeters used as measuring instruments during technical inspection at the technical inspection lines must meet the requirements from “Rulebook on opacimeters” [24]. This rulebook also states the measuring units, the opacimeter marking, method of determining whether the requirements have been

met and opacimeter certification. “Rulebook on measuring instruments” [25] has annexes dedicated to characteristics and performance of some measuring instruments used at the vehicle technical inspection units, like materialized length gauges (Annex MI-008, Chapter I) and exhaust gas analyzers (Annex MI-010). It is obvious that international and national bodies that make laws and regulations should continuously work on modernization and harmonization of regulations on vehicle technical inspection in order to keep up with technological progress and environmental and road safety issues.

4. CONCLUSION

The measuring instruments, devices and tools used during vehicle PTI are critical for ensuring that vehicles are roadworthy and compliant with environmental regulations. Regular inspection, servicing, cleaning, calibration and compliance with corresponding standards and regulations help guarantee the reliability of the inspection results and road safety. The main objective of the present regulations on vehicle PTI is to significantly reduce road traffic accidents caused by inadequate vehicle maintenance. This means that regulations should timely take into account some new occurrences, like growing presence of electric vehicles and new technologies: artificial intelligence (AI), data analytics and digitalization applied on smart and automated vehicles. Actually, the future of technical regulations on vehicle inspections is likely to be shaped by emerging technologies, environmental goals and increasing emphasis on safety and connectivity. The use of automation, remote diagnostics, AI-driven analysis and data-driven decision-making will redefine how vehicles are inspected and maintained. Accordingly, new rules for technical inspection should prescribe PTI for electric vehicles, new tests for advanced driver-assistance systems (ADAS) and advanced emission test methods for detecting fine particles pollutions.

This research was financially supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia [Contract No. 451-03-137/2025-03/200107].

LITERATURE

- [1] World Health Organization: *Global status report on road safety 2023*, World Health Organization, ISBN 978-92-4-008651-7 (electronic version), Geneva, Switzerland, (2023).
- [2] UNECE: *Consolidated text of the 1997 Agreement on Periodic Technical Inspection of wheeled vehicles*, ECE/TRANS/WP.29/2020/38, UNECE, Geneva, Switzerland, (2020).
- [3] UNECE: *Uniform Provisions for Periodical Technical Inspections of Wheeled Vehicles with regard to the Protection of the Environment (Rule No. 1)*, ECE/RCTE/CONF/4/Add.1/Rev.2, UNECE, Geneva, Switzerland, (2018).
- [4] UNECE: *Uniform provisions for periodical technical inspections of wheeled vehicles with regard to their roadworthiness (Rule No. 2)*, ECE/RCTE/CONF/4/Add.2/Rev.1, UNECE, Geneva, Switzerland, (2018).
- [5] UNECE: *Periodical Technical Inspections of motor vehicles using Compressed Natural Gas (CNG), Liquefied Petroleum Gas (LPG) and/or Liquefied Natural Gas (LNG) in their propulsion system (Rule No. 3)*, ECE/RCTE/CONF/4/Add.3, UNECE, Geneva, Switzerland, (2019).
- [6] UNECE: *Uniform provisions for periodical technical inspections of motor vehicles equipped with electric or hybrid propulsion system(s) with regard their roadworthiness (Rule No. 4)*, ECE/RCTE/CONF/4/Add.4, UNECE, Geneva, Switzerland, (2019).
- [7] UNECE: *Proposal for a new Rule (1997 Agreement)*, ECE/TRANS/WP.29/GRSG/2023/6, UNECE, Geneva, Switzerland, (2023).
- [8] UNECE: *Resolution R.E.6 on the administrative and technical provisions required for carrying out the technical inspections according to the technical prescriptions specified in Rules annexed to the 1997 Agreement*, ECE/TRANS/WP.29/1132, UNECE, Geneva, Switzerland, (2017).
- [9] UNECE: *Mutual Resolution No. 1 (M.R.1) of the 1958 and the 1998 Agreements*, ECE/TRANS/ WP.29/ 1101, UNECE, Geneva, Switzerland, (2013).

- [10] European Parliament, Council of the European Union: Directive 2014/45/EU, *Official Journal of the European Union*, (2023), p.p. L127/51-L127/128.
- [11] European Commission: *Roadworthiness package annexes*, European Commission, Brussels, Belgium, (2025).
- [12] European Parliament, Council of the European Union: Directive 2014/47/EU, *Official Journal of the European Union*, (2014), p.p. L127/134-L127/218.
- [13] ISO: *ISO 20730-1:2021(E) Road vehicles - Vehicle interface for electronic Periodic Technical Inspection (ePTI) - Part 1: Application and communication requirements*, ISO, Geneva, Switzerland, (2021).
- [14] ISO: *ISO 20730-2:2022(E) Road vehicles - Vehicle interface for electronic Periodic Technical Inspection (ePTI) - Part 2: Application and communication requirements conformance test plan*, ISO, Geneva, Switzerland, (2022).
- [15] ISO: *ISO 20730-3:2021(E) Road vehicles - Vehicle interface for electronic Periodic Technical Inspection (ePTI) - Part 3: Data definitions*, ISO, Geneva, Switzerland, (2021).
- [16] National assembly of the Republic of Serbia: The road traffic safety law, *Official Gazette of the Republic of Serbia*, No. 19/2025, (2025).
- [17] Minister of the interior affairs of the Republic of Serbia: The rulebook on registration of motor vehicles and trailers, *Official Gazette of the Republic of Serbia*, No. 31/2025, (2025).
- [18] Minister of the interior affairs of the Republic of Serbia: The rulebook on technical inspection of vehicles, *Official Gazette of the Republic of Serbia*, No. 62/2022, (2022).
- [19] National assembly of the Republic of Serbia: Metrology Act, *Official Gazette of the Republic of Serbia*, No. 15/2016, (2016).
- [20] Minister of economy of the Republic of Serbia: Rulebook on types of measuring instruments subject to legal control, *Official Gazette of the Republic of Serbia*, No. 84/2022, (2022).
- [21] Minister of economy of the Republic of Serbia: Rulebook on reglosopes, *Official Gazette of the Republic of Serbia*, No. 120/2021, (2021).
- [22] Minister of economy of the Republic of Serbia: Rulebook on measuring instruments for measuring braking force in motor vehicles, *Official Gazette of the Republic of Serbia*, No. 13/2020, (2020).
- [23] Minister of economy of the Republic of Serbia: Rulebook on manometers for measuring tire pressure, *Official Gazette of the Republic of Serbia*, No. 66/2014, (2014).
- [24] Minister of economy of the Republic of Serbia: Rulebook on opacimeters, *Official Gazette of the Republic of Serbia*, No. 15/2015, (2015).
- [25] Minister of economy of the Republic of Serbia: Rulebook on measuring instruments, *Official Gazette of the Republic of Serbia*, No. 105/2024, (2024).