

**International Congress  
Motor Vehicles & Motors 2016**

**VEHICLE AS A KEY FACTOR  
IN TRANSPORTATION**

**Proceedings**



Ministry of Education,  
Science and Technological Development

October 6<sup>th</sup> - 7<sup>th</sup>, 2016  
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**International Congress  
Motor Vehicles & Motors 2016**

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**PROCEEDINGS**

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# PREDGOVOR

Fakultet inženjerskih nauka u Kragujevcu (ranije Mašinski fakultet) tradicionalno u oktobru održava skupove istraživača i naučnih radnika koji proučavaju motorna vozila, motore i drumski saobraćaj. Od 1979. do 2004 godine je održano trinaest Simpozijuma MVM koji su 2006 godine prerasli u internacionalni Kongres. Od tada je održano pet Kongresa MVM a ovog meseca, oktobra 2016. godine, Fakultet inženjerskih nauka Univerziteta u Kragujevcu organizuje šesti Internacionalni Kongres MVM.

Za VI Kongres MVM- 2016 je prijavljen veći broj naučnih radova iz zemlje i inostranstva. Kongres je tradicionalno podržan od Ministarstva za prosvetu, nauku i tehnološki razvoj Republike Srbije, kao i od Agencije za bezbednost saobraćaja i velikog broja prijatelja i saradnika iz delatnosti vezanih za vozila i drumski saobraćaj.

Moto Kongresa „MVM2016“ je „Vozilo kao ključni faktor u transportu“. Radovi istraživača i naučnih radnika iz oblasti motornih vozila, motora i drumskog saobraćaja koji su publikovani na Kongresu „MVM2016“ i ovoga puta su pokazali značaj istraživanja u oblasti vozila, motora i drumskog saobraćaja.

Razvoj, proizvodnja i eksploatacija vozila nalaze se dugi niz godina u žiži interesovanja velikog broja ljudi širom sveta. Unapređenje bilo koje delatnosti koja je u vezi sa unapređenjem proizvodnje i eksploatacije vozila predstavlja doprinos poboljšanju uslova života svih živih bića.

Pred vozilima se danas postavljaju vrlo strogi zahtevi u pogledu tehničkih i ekoloških karakteristika. Vozila koja se danas proizvode, zahvaljujući prvenstveno radu velikog broja istraživača i naučnika, imaju svakim danom sve bolje eksploataciono-tehničke karakteristike.

Vozila, kao multi-disciplinarni objekat razvoja i istraživanja sa jedne strane, i kao potreba sa druge, uvek su aktuelna za razvoj i ulaganja. Vozila su sredstva koja su u službi čoveka pri najrazličitijim delatnostima. Zato je i razumljivo da su teme naučnih i stručnih radova, koje se obrađuju u okviru Kongresa MVM 2016 sve raznovrsnije i da se okviri istraživačkog i naučnog rada u ovoj oblasti sve više šire.

U Kragujevcu,  
oktobar, 2016. godine

Naučni i organizacioni odbor  
Kongresa MVM2016

# FOREWORD

In October, the Faculty of Engineering from Kragujevac (former Faculty of Mechanical Engineering) traditionally holds gatherings of researchers and academics who study motor vehicles, engines and road traffic. From 1979 to 2004, thirteen MVM Symposiums have been held and they grew into an International Congress MVM in 2006. Since then, five MVM Congresses have been held and this month, in October 2016, the Faculty of Engineering of the University of Kragujevac organizes the sixth International Congress MVM.

A large number of scientific papers from the country and abroad were submitted to the sixth Congress "MVM2016". Congress is traditionally supported by the Ministry of education, science and technological development of the Republic of Serbia, as well as by the Road traffic safety agency and by a large number of friends and associates from activities related to vehicles and road traffic.

The motto of the Congress "MVM2016" is "Vehicle as a key factor in transportation". The papers of the researchers and the academics from the field of motor vehicles, motors and road traffic, published at the Congress "MVM2016", have shown this time the importance of research in the field of vehicles, motors and road traffic.

Development, production and exploitation of vehicles are for many years in the spotlight of a large number of people around the world. Promotion of any activity that is related to improvement of production and exploitation of vehicles represents a contribution to improving the conditions of life of all living beings.

Very strict requirements are set in front of vehicles today in terms of technical and environmental characteristics. Vehicles that are produced today have better and better exploitation-technical characteristics, primarily due to the efforts of many researchers and scientists.

Vehicles, as multi-disciplinary objects of research and development on the one hand, and as necessities on the other, are always valid for development and investment. Vehicles are assets that are at the service of man for various activities. Therefore, it is understandable that the topics of scientific and professional papers, presented in the framework of the Congress "MVM2016", are more and more diversified and that the frameworks of research and scientific work in this area are increasingly wider.

Kragujevac,  
October 2016

Congress "MVM2016"  
Scientific and Organizational Boards





















































































































































































































































































































































































































































































































































































































































































































































































































































































































































































































































