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Letter to the Editor

Analysis of the participant solutions of the first Student International Olympiad on Mechanism and Machine Science

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ABSTRACT

Conducting student contests promotes student interest to a science, and discloses the youth creativity. The top ranking competitions reveal the best students on the international level, engage them in their future professional career as well as compare the educational systems, adopted in different countries. The Student International Olympiads (SIO) on Mechanism and Machine Science (MMS), introduced by IFToMM in 2009, can be considered a new advantageous form of MMS study. The paper analyzes the participant solutions of the first SIO MMS, which was held on April 19–21, 2011 in Izhevsk (Russia) at Izhevsk State Technical University.

1. Introduction

The first Student International Olympiad (SIO) on Mechanism and Machine Science (MMS) was held on April 19–21, 2011 in Izhevsk (Russia) at Izhevsk State Technical University (ISTU). The decision for conducting SIOMMS was adopted at the session of IFToMM Executive Council (EC) in Guanajuato, Mexico in June 2009.

17 student teams from 8 countries participated in the competition: Alexander Dubcek University of Trencin (Slovak Republic); Brno University of Technology (Czech Republic); Damascus University (Syria); Egyptian-Russian University (Egypt); Shanghai Jiao Tong University (China); Slovak University of Technology in Bratislava (Slovak Republic); University of Pecs (Hungary); Volodymyr Dahl East Ukrainian National University (Ukraine); and Wuhan University of Science and Technology (China). Russia was represented by 8 universities: Academician S. P. Korolev Samara State Aerospace University; Bashkir State Agrarian University (out of competition); Chuvash State University; Izhevsk State Technical University; Kostroma State Technical University; South Ural State University (out of competition); Ufa State Aviation Technical University; and Volgograd State Technical University [1].

Among the honored guests of the Olympiad were: Professor Marco Ceccarelli (Italy), President of IFToMM, professor of the University of Cassino; Professor Joseph Rooney (UK), member of IFToMM Executive Council; Professor Veniamin Goldfarb (Russia), member of IFToMM Executive Council, Director of the Institute of Mechanics, chief of Department of ISTU; Acad. Mikhail Kalashnikov (Russia), legendary Chief Designer of Small Arms.

2. Contest problems

The contest problem list included 8 items, shown in Table 1. The example of the contest problem is illustrated in Fig. 1.

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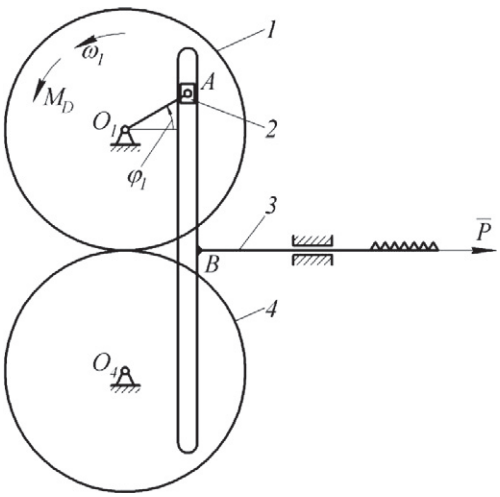
Table 1
List of the contest problems.

No	Topic
1	Kinematical analysis of a coulisse mechanism, determining the advance-to-return time ratio for a driven link
2	Kinematical analysis of a cam mechanism
3	Determining the kinetic energy of a linkage member
4	Kinematics of a spur gear engagement (finding velocity of the teeth relative sliding)
5	Synthesis of a gearbox: selecting numbers of teeth with the mechanism's gear ratio given
6	Dynamics of a coulisse mechanism (setting up the differential equations of motion; balancing an inertia force by means of attaching two counterweights)
7	Investigation of running the machine press supplied with a flywheel
8	Investigation of a cam mechanism dynamics with the given equation of the follower motion

Problem 6 ***(9 scores)***

In the mower cutting mechanism shown below the crank O_1A rigidly attached to gear wheel 1, imparts motion to rocker *3* (the mower knife) by means of the slider *2*. Gear wheels *1* and *4* have number of teeth z_1 and z_4 , correspondingly.



The values of quantities listed below are assumed as known:

- crank length l_{OA};
- links *2* and *3* have masses m_2 and m_3, respectively, the center of mass of the link *2* is at point *A* while that of the link *3* is at point *B*;
- the moment of inertia of the wheel 1 keyed with the crank equals that of wheel 4, $I_{O_1}^{(1)} = I_{O_4}^{(4)}$ (both are known); the moments of inertia are calculated about axes of rotation; mass centers lay on the axes of rotation;
- constant working load *P*, acting on the rocker *3*;
- driving torque M_D, acting on the wheel *1*.

Questions

1. Set up the differential equation of the mechanism motion.
2. Counterbalance the inertia force acting on the rocker *3* by means of attaching two identical counterweights of mass *m* to the wheels *1* and *4*. Determine the masses of counterweights and angular positions they must have on wheels. Both masses should be at a distance *r* apart the axes of the wheels. The crank rotates at a constant angular speed of ω_1.

Fig. 1. Example of a contest problem.