

THE CONCEPT OF HOLDING THE INTERNATIONAL ENGINEERING MECHANICS CONTEST

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Summary There is the information about International Engineering Mechanics Contest for university students, which is held at the Belarusian State University of Transport. The analyses of Contest structure and problems are given.

INTRODUCTION

Engineering mechanics is one of the fundamental disciplines which significantly influences the students' scientific outlook. At the same time it is the basis for the successful studying of engineering disciplines. So students are to learn to navigate in a variety of professional problems during engineering mechanics course and getting other fundamental knowledge. Contest is a way for the qualification improvement of future engineers. Students are to meet with non-standard methods of solving the complex tasks which will be useful for their future practice.

Since 2005 the Department of Technical Physics and Engineering Mechanics of Belarusian State University of Transport is organizing and holding the International Engineering Mechanics Contest.

During the seven years 746 students as well as academic staff from such countries as Belarus, Kazakhstan, Poland, Russia, Sweden, Transdnistria and Ukraine have taken part in the Contest. The Organizing Committee has received the expressions of interest and probable participations of the teams from Canada, Egypt, Mexico, Mongolia, Turkmenistan, Vietnam and some other countries.

THE CONTEST

The International Contest represents the history of the development of Belarusian National Contests held since 1982. The Contest consists of two parts: Theory Contest (Individual and Team Events) and "Brain-ring" Team Contest.

For the Theory Contest the teams (3–6 students) are set with 8 problems (2 – statics, 2 – kinematics and 4 – dynamics) for 4 hours. The supervisors of teams-participants act as the Panel of Judges, they control the process and take part in problem solution checkups.

The Theory Contest results in Individual Events are assessed by summing up the participants' points. Results in Team Events are assessed by summing up three best points of team's participants.

The "Brain-ring" Team Contest lasts for 60 minutes. The teams (3 students) are set with 30 short problems: 10 for each - statics, kinematics and dynamics. Each task is given 1 point for the right answer. The process of task solving is not taken into consideration. If the team exceeds the time limit it is scored with 1 demerit point for 2 extra minutes. The "Brain-ring" Team Contest results are assessed by the number of correctly solved problems.

PROBLEM SITUATIONS

The study of the Engineering Mechanics Course may vary at different universities and countries. Besides, in accordance with the curriculums for various specialties there may be different number of subject hours. This means that the course may differ both in content and duration. So while selecting the problems for the Theory Contest it is necessary to set the tasks which may be solved by standard methods of mechanics. However, there have to be some of the elements that distinguish these problems from the routine ones.

There is a tendency in students' thinking that the friction force is always equal to the product of the coefficient of friction and the surface normal reaction. This stereotype is formed because the vast majority of the problems offered to them for self-studying consider a critical case true to the maximum value of the friction force. But the relative rest of bodies the friction force may be less than the specified product. The solution of such problems requires further analysis of the conditions and the analysis of the adequacy of the receiving results to real situations.

While making up the sets of the Contest tasks a number of conditions should be observed. The tasks should be of different levels of complexity, but the most complicated ones are to be solved by at least 10 % of the participants. One or two tasks may be routine. At the same time in order to choose the best students an excessive number of tasks (eight) should be offered. The practice has shown that 4 hours is enough to solve the problems. The experience shows that the leaders in this case are gaining less than 90 % of the maximum possible points and it allows to define who is a real winner.

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The "Brain Ring" Contest has led to the need in more rational solutions for each task which must be performed by just a few operations. At the same time due to the large number of tasks there is an opportunity to include the most aspects of Engineering Mechanics course. In addition to the routine tasks which must be at least $\frac{1}{4}$ of the total, a more complicated tasks should be included to get a more objective team results.

Let's take some tasks as examples to illustrate the process.

Problem 1 (Fig. 1). The disk with radius R is rolling over the stationary disk with radius $2R$. The centre of the small disk circuits the centre of the big disk (one complete revolution). How many times does the small disk circuit its own axis?

The peculiarity of this problem is the need to calculate the angle of rotation of the disk rather than its angular velocity. Most of the participants of the Contest did it proceeding from the displacement of a point of contact drives and did not take into account the rotation of the tangent to the disk. At the same time the best solution is the integration of the expression that relates the angular velocity of a small disk and the linear velocity of its center.

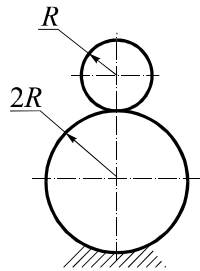


Fig 1. Problem 1

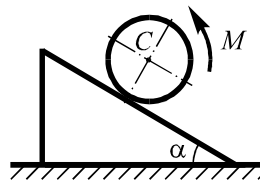


Fig 2. Problem 3

Problem 2. Drawing force varying under $F = 4000t$ N law comes in action upon an idle tram on level track with $m = 20000$ kg weight. Resisting forces interfere with the tram movement, and the modified friction coefficient is $f = 0,02$. Calculate the speed of the tram at $t = 2$ s.

The peculiarity of this problem is the need to take into account the fact that the motion of the tram starts not at the beginning of the force application but at time $t = 1$ s.

Problem 3 (Fig. 2). A wheel is rolling with skidding along an inclined plane with α angle towards horizon under M turning moment applied. Find C wheel centre of mass acceleration if sliding friction coefficient is f .

The peculiarity of this problem is that the friction force is motive force here, and the answer does not depend on the specified moment.

The Contest results have shown that the winners of the "Brain Ring" Contest can get 20–26 points. The presence of tasks with a low level of complexity allows to avoid zero results for any of the teams.

The "Brain-Ring" Contest promotes students' quick thinking and enables them to work under pressure and find the solutions jointly.

CONCLUSIONS

Contests are useful both for students and the academic staff. The analysis of the mistakes allows to figure out what questions cause the greatest difficulties in the course and then pay more attention to them when delivering the lecture. The academic staff while preparing tasks for the Contest and solving the advanced problems get acquainted with the various non-standard methods of their solving and therefore advance in skills.

The participants' interest in the subject is growing and then they are happy to accept the invitations to do other research work. With the help of the computer technologies they solve the problems which investigate the phenomena occurred in various mechanical systems. The results of these studies are then used by students in the study of special subjects, course and diploma projects.