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МОДЕЛИРОВАНИЕ РАБОЧИХ РЕЖИМОВ ТЯГОВО-ТРАНСПОРТНЫХ МАШИН

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The leading sectors of the Belarusian industry include machine building, metalworking and machine-tool building. Effective development of all sectors of industry of the Republic of Belarus is crucially dependent on machine building. Advanced scientific and technical ideas are implemented, new mechanisms and machines that determine progress in other sectors of the economy are primarily created in this sector.

Machine building is a major branch with dynamic development of agricultural and transport areas. Machine-building complex of Belarus includes about 140 enterprises operating in such fields as machine-tool construction, automobile construction, agricultural machinery, road construction vehicles etc.

Production of vehicles and agricultural machinery is a key direction of machine building. The country produces annually about 60,000 tractors, more than 20,000 trucks and approximately 2,000 buses and combine harvesters. “Belarus” tractors, “MAZ” trucks, “BelAZ” dump trucks, “Gomselmash” agricultural machinery and other products of the Belarusian engineering are known worldwide.

Modern engineering is characterized by increased requirements to the technical level, quality and reliability, safe operation and maintenance of machines and mechanisms. It makes it necessary to automate the design phase, improving the design of new mechanisms and their production technology, and introduce new materials and more accurate methods of calculation.

Further improvement of technical and economic level and quality of engineering products depends on how successfully the following problems will be solved:

– expanding the scopes of use of automated design;
– increasing the reliability and lifetime performance of machines;
– reducing the consumption of materials;
– achieving energy efficiency, increasing the efficiency of mechanisms.

The key points in the solution of these problems are improvement of calculation and optimization of mechanisms and machines, which in turn can be solved using modern computer technology.

Towing vehicles belong to the agricultural, construction and road engineering and are applied in wheeled self-propelled machines and tractors working with semi-mounted machinery, trailers and semi-trailers. Engine is an integral part of the towing vehicle. It is known that the optimal control mode of the engine towing vehicles is an important way to increase their productivity, fuel efficiency and other performance indicators.

Crank mechanisms are among the most common mechanisms in modern engineering. They are widely used in a variety of devices (compressors and pumps, crank presses, engines, machines, etc.). A crank mechanism is intended for converting a rectilinear translational movement in the expansion stroke of the piston into rotary motion of the crankshaft, and in other strokes - a rotary motion of the crankshaft into linear reciprocation of the piston. The reliability, efficiency, structural dimensions of a crank mechanism depend on the right justification and the choice of its parameters. Justification of ways of extending functionality of the crank mechanism is based on the study of the structural synthesis and kinematic characteristics of the new mechanisms, the use of which leads to a qualitatively different technical solutions while maintaining the structure of the scheme or the type of mechanism.

The aim of dynamic analysis of mechanisms is to study the methods of determining the forces acting on its parts during movement, and the relationship of these forces with the movement and the masses of the parts.

The issue of determining the forces acting on the parts of the mechanism or their components, is of great practical importance. This allows us to solve a number of important issues related to, for example, the problem of reducing the dynamic loads in support bearings, to optimization modes of movement of the mechanism, to the phenomenon of oscillation in the mechanisms, to the problem of the collision of parts of the mechanism, to determining the power requirements for the operation of the mechanism, to the determining friction and wear in kinematic pairs, etc. The dynamic study of the mechanism is preceded by its kinematic analysis, which is performed solely on the basis the mechanism structure and geometric relationships between the dimensions of its parts.

Thus, the automation of kinematic and dynamic analysis of the crank mechanism is an important issue.

The objective of the research is the mathematical modeling of the dynamics of the mechanisms on the example of development of program for kinematic and dynamic analysis of the crank mechanism.

The research continues a series of papers of the department “Maintenance of cars” of the Belarusian-Russian University in the field of dynamics of wheeled and traction transport vehicles.

Some of the major tasks of the department’s scientific research are:

– development of design methods for wheel brake mechanisms which are adaptive to the active safety systems of cars and articulated trucks;

– development of automatic control methods for driving dynamics and traction transport modes of mobile wheeled cars;

– development of automatic control methods for emergency braking of wheeled vehicles;

– development of mathematical modeling methods for the dynamics of movement of wheeled vehicles and long-haul trucks using computer technologies;

– development of an electronic system component for automatic brake control systems of cars and trucks;

– development of theoretical bases of the active vibration isolation systems of wheeled vehicles on the power analysis.

In the research of the scientists of the department "Maintenance of cars" mathematical models of the crank mechanism are used.

The methodology of modeling the dynamics of link mechanisms on the example of the software developed during the studies in the field of dynamics of wheeled and traction transport vehicles has been developed. The methodology developed makes it possible to perform kinematic and dynamic analysis of link mechanisms. The graphical user interface is informative and facilitates visual perception of the results.

In order to carry out automated kinematic and dynamic analysis of the mechanism on the computer it is necessary to code the parameters which describe the structure, the geometry and mass distribution of the system.

The developed software allows:

– setting the initial parameters for kinematic analysis;

– setting the initial parameters for dynamic analysis;

– performing kinematic analysis of the mechanism;

– producing dynamic analysis of the mechanism;

– plotting an indicator diagram, a graph of gas pressure on the piston, a graph of equivalent moment of total inertia and inertia of a group, a graph of equivalent moment of inertia, a graph of equivalent moment of the model, a graph of the kinetic energy of the model, a graph of the model work, a graph of the angular velocity of the model, a mass and energy diagram.

Scientific novelty of the received results consists in the following:

– integration of software module developed on the object-oriented programming language C # with the MATLAB math library package;

– application of ZedGraph class libraries under the .NET Framework to show the results of the simulation.