FIRST-ORDER DIFFERENTIAL EQUATIONS AND THEIR APPLICATIONS

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Annotatsiya: *Mazkur maqolada differensial tenglamalar to'g'risida qisqacha umumiy tushunchalar berilib, so'ngra differensial tenglamalarning real amaliy masalalarga tatbiqi berilgan. Bunda muayyan amaliy masala differensial tenglama yordamida hal qilingan.*

Kalit soʻzlar: *Differensial tenglama, tenglamaning tartibi, funksiya, o'zgarmas miqdor, tezlik, tezlanish, harakat, tortishish kuchi, qarshilik kuchi, avtomobil, dvigatel.*

Аннотация:*В этой статье дается краткое общее представление о дифференциальных уравнениях с последующим применением дифференциальных уравнений к реальным практическим задачам. В данном случае конкретная практическая задача решалась с помощью дифференциального уравнения.*

Ключевые слова:*Дифференциальное уравнение, порядок уравнения, функция, постоянная величина, скорость, ускорение, движение, сила тяжести, сила сопротивления, автомобиль, двигатель.*

Annotation: *This article provides a brief general overview of differential equations and then discusses their applications to practical problems. A specific practical problem is solved using a differential equation.*

Keywords: *Differential equation, order of an equation, function, constant quantity, velocity, acceleration, motion, gravitational force, resistance force, automobile, engine.*

Definition 1. An equation involving an unknown function and its derivatives is called a differential equation.

Definition 2. If the unknown function involved in a differential equation is a one-dimensional function (i.e., a function of only one variable), this equation is called an ordinary differential equation.

The highest order of the derivatives involved in the equation is called the order of this equation. Therefore, the general form of an n-order ordinary differential equation is as follows:

$$F(x, y(x), y`(x), y``(x) ,\ldots\ (x)) = 0 \qquad (1)$$

where x is an arbitrary variable, y=y(x) is an unknown function, -

k-order derivative of an unknown function.

Many processes in physics, economics, biology, chemistry, medicine and other sciences are described using differential equations. By studying differential equations, we gain information about the relevant processes. These differential equations are a mathematical model of the process under study, and the study of differential equations leads to a complete description of the processes. Let's look at some of these problems

Problem 1. An object with a mass m is dropped from a certain height. If, in addition to the force of gravity, the body is affected by the air resistance force proportional to the speed (proportionality coefficient k), it is necessary to know by what law the falling speed υ of this object changes, that is, to find the relation υ=f(t).

Solution: According to Newton's second law,

in this is the acceleration of a moving object (the product of velocity with respect to time), and F is the force acting on the object in the direction of motion, which consists of the force of gravity mg and the force of air resistance (- k v). Since the force of air resistance is opposite to the direction of velocity, we take it with a negative sign. Thus,

(1)

We are dealing with the unknown function v and its derivative we have formed a relation expressing the connection between, that is, a differential equation with respect to the unknown function υ. Solving a differential equation means finding the function υ=f(t) that exactly satisfies the given differential equation. There are infinitely many such functions that satisfy the differential equation. Any

v = C + (2)

The reader can easily check that the function in the form of C satisfies equation (1) for any constant. Which of these functions gives the desired relationship of υ through m? To find this, we use an additional condition: when the body was thrown, it was given an initial velocity (which in a special case can be zero), we assume that this initial velocity is known. But in this case, the desired function υ=f(t) must be such that when t= 0 (at the beginning of the motion) for it v= condition must be met. (2) to formula t=0, v = was put

= C + ,

from this

.Thus, the constant C has been found. Hence, the sought-after relationship between υ and t is: : (3)

(4)

From expression (4) if k= 0 (i.e. air resistance is absent or negligible), then we have the following known from physics:

(5)

The formula is determined. The found function υ satisfies the differential equation (1) and the initial condition υ = , when t = 0.

Problem 2. Let's consider the mathematical representation of the horizontal motion of a car and its modeling. When assessing the operational characteristics of a car, the maximum acceleration and braking indicators are analyzed.

In studying the dynamics of car motion, the car is considered as a single (whole) part. The car is a moving system, and several forces act on it. To mathematically represent the motion of a car, it is necessary to know the forces acting in the process of motion. In particular: the forces that set the car in motion, the forces that resist its movement, weight and reaction forces. Figure 1 shows a schematic representation of the forces acting on a two-axle car. For the car to move, it is necessary to take into account the resistance forces acting on it. The force that moves the car is the force of gravity.Avtomobilning harakatiga qarshilik qiluvchi kuchlar esa quyidagilar: havoning aerodinamik qarshilik kuchi hamda ishqalanish kuchlaridir.

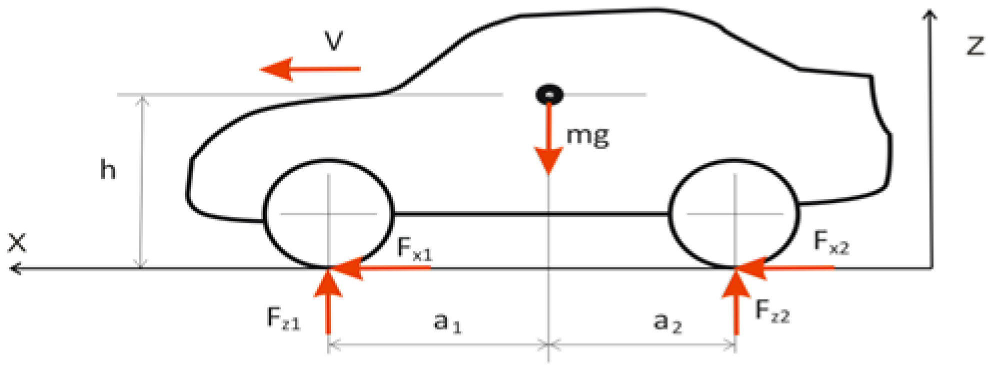

Figure 1. Schematic representation of the dynamics model of a two-axle vehicle moving horizontally.

When a two-axle vehicle moves in the longitudinal direction, it is subject to the following main forces: aerodynamic forces, forces resisting movement on the front and rear wheels, inertial forces, normal forces acting on the wheel axles, projections of normal forces on the slope, and the gravitational forces that move the vehicle. The equation of motion of the vehicle in the horizontal direction is expressed as follows:

here,

- – drag force, N(Newton);
- - aerodynamic force, N(Newton);
- – rolling resistance, N(Newton);
- car acceleration, m/s2;
- mg heavy force, N(Newton);
- road slope, oC(Gradus).

Gravity of the car

The traction force of a car is determined by the ratio of the torque transmitted from the engine's drive shaft to the driving wheel to the wheel radius.

The traction force is determined experimentally, that is, using special stands. If there are no experimental values of the traction force, it can also be calculated using its external speed characteristic.

The maximum traction force of a car engine is defined as follows:

- power transmitted from the engine to the driving wheels, N(Newton);
- engine torque, Nm;
- – number of gears in the transmission;
- – in transmission useful work coefficient;
- – dynamic radius of the wheel, m.

The relationship between the engine's torque and its angular velocity is expressed as follows:

Here, am, bm and cm coefficients are the coefficients of the polynomial function, – engine angular velocity, rad/s.

The vehicle speed v and the crankshaft rotation speed using the linear relationship between , we determine the following: va

Here , – the angular velocity of the wheel and – wheel radius.

Forces resisting the rotation of a car wheel

The rolling resistance of a wheel is the energy expended in overcoming the resistance of a car tire to rolling on the road. Part of this energy is spent on overcoming the friction of the tire on the road, the resistance of the bearings in the wheel hub and the rotation of the wheel, and air resistance. Due to the difficulty of taking into account all the above reasons, the rolling resistance of the wheel is determined by empirical mathematical expressions for the car.

The rolling resistance of the wheel is found by the following mathematical expression:

Here, − the coefficient of rolling resistance. This coefficient varies according to a polynomial function proportional to the speed of the vehicle, that is:

Here, − coefficient of resistance to shaking under normal loading. , and coefficients are adopted based on the results of an experiment conducted on the type of tire.

Resistance to climbing a slope

Heights are also found on highways. The longitudinal slope of the road corner or is determined by. The resistance force to climb a slope is found as follows:

Friction force between the road and the wheel

Frictional force Pφ is an internal force, which is the internal force that occurs when the friction between the wheel and the road and the friction of the tire elements with the road are taken into account. Therefore, the friction force is the force that resists the sliding of the wheel relative to the road. It is calculated as follows. For a car with all-wheel drive:

Here, φ– the coefficient of friction between the wheel and the ground, and – gThe force of gravity acting on the wheel.

The physical property of the coefficient of friction takes into account the coefficient of friction accepted in mechanics, that is, the mechanical friction of the tire with the road surface. The value of the coefficient of friction depends on the type of road, soil condition, tire tread profile, tire internal pressure, weight force acting on the wheel, and other factors. Wetting of the road surface reduces the coefficient of friction, since a thin film is formed from water and small particles of soil. The film separates the rubbing surfaces, reducing the adhesion between the tire and the road.

Air resistance

When a car moves, it encounters air resistance, and engine power is used to overcome it. Air resistance to the movement of a car consists of the pressure difference between the front and rear of the moving car, the resistance of the air as it passes through the radiator fins and under the hood, and the friction of the car body with the air layer. As you can see, the air resistance force is applied to different points of the car. Therefore, the acting elementary resistance forces are concentrated and added at one point, and its equivalent effect is the air resistance force on the car is determined by.

Aerodynamic force of the car defined as:

Here,

- − air density coefficient, kg/m3;
- − aerodynamic drag coefficient;
- − car cross-section surface, m2 ;
- − car speed, m/s.

Using the equations above, we express the general equation of motion of the car in terms of all the forces acting on it and the speed of the car, and after simplification, the resulting equation is expressed as follows:

So, as can be seen from the equation of motion of the car, it is expressed in first-order differential form. If we simplify this equation by substituting each force into it, we get:

Here, , and coefficients that depend on the design of the vehicle and road conditions. These coefficients are determined as follows:

Here, , , — coefficients in the internal combustion engine torque equation; − air density coefficient, kg/m3; − aerodynamic drag coefficient; − car cross-section surface, m2; − road slope angle, oC; – the number of transmission gears in the gear; - in transmission useful work coefficient; – dynamic radius of the wheel, m; – the radius of the wheel, m; − coefficient of resistance to shaking under normal load.

When studying the movement of a car, its movement in various modes is studied: under the influence of gravity (acceleration, acceleration); movement when gravity is not present; movement when braking.

Since 1945, a catalog of cars manufactured around the world has been developed. It contains a complete database of the characteristics and technical parameters of more than 250,000 cars http://www.automobile-catalog.com/ the website is updated and updated annually. The solution to the differential equation is determined based on the technical parameters of the car taken from this site.

Summary

This article studies the theoretical foundations of first-order differential equations and their application to practical problems. Physical processes are described using differential equations on the example of determining the fall velocity of a body with a mass m and mathematical modeling of the horizontal motion of a car.

During the study, a mathematical model of car motion was constructed, taking into account the main forces acting on the car - gravity, aerodynamic resistance, road slope, and friction forces. The resulting equation was expressed in the form of a first-order differential equation, and the law of change in car acceleration was determined on its basis.

The results obtained confirm the effective application of differential equations in the study of car dynamics. This approach can be widely used in modeling processes not only in mechanics, but also in other natural and technical sciences.

REFERENCES:

1.Tuhtasinov M., Ergashev T. Differensial tenglamalar fanidan misollar va masalalar yechish. T.: "Innovatsion rivojlanish nashriyotmatbaa uyi", 2020.

2. Салоҳитдинов М.С., Насритдинов Ғ.Н. Оддий дифференциал тенгламалар. Т., "Ўзбекистон", 1994.

3. Turgunbayev R., Matematik analiz. 2-qism, T. TDPU, 2008 y.

4. Polyanin A.D., Zayetsev V.F. (2003). Handbook of Exact Solutions for Ordinary Differential Equations. Chapman & Hall/CRS.

5.Samatov B., Umarov E. (2016). Differensial tenglamalar. Namangan davlat universiteti.