

EXPLAINING DERIVATIVES IN ENGLISH WHEN SOLVING PROBLEMS IN VARIOUS FIELDS

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Abstract: This article analyzes applications of the derivative in mathematics and physics in relation to important processes in hydraulic structures and pumping stations. In particular, it is explained how problems such as determining the speed of water flow, calculating hydrostatic pressure, modeling erosion processes and assessing the efficiency of pumps are solved with the help of the derivative. The importance of the derivative in the study and optimization of hydraulic processes is stated by scientific foundations. Each example in the article is supplemented with graphic drawings, with a special emphasis on their practical application. This work contributes to the accurate and efficient execution of engineering calculations in the field of hydraulic engineering.

Keywords: Derivative, differential, limit, hydraulic, speed, pressure, flow rate, erosion, acceleration.

Introduction

To a function $y=f(x)$ (1) defined in a range x at every value of the argument in that range, the function $y=f(x)$ has a known value.

Let Argument X get some (positive or negative) Δx gain. At that time, the function y takes some Δy gain. Thus we have $y = ()$ at the X value of the argument, and $x+\Delta x$ of the argument. The gain of the function Δy we find:

$$\Delta y = (f(x + \Delta x)) - (f(x))$$

We construct the ratio of function gain to argument gain:

$$\frac{\Delta y}{\Delta x} = \frac{f(x + \Delta x) - f(x)}{\Delta x}$$

We find the limit of this ratio at $\Delta x \rightarrow 0$. If this limit exists, it is called the derivative of a given () function and is denoted by ' (). Thus, by definition:

$$f'(x) = \lim_{\Delta x \rightarrow 0} \frac{\Delta y}{\Delta x}$$

or

$$f'(x) = \lim_{\Delta x \rightarrow 0} \frac{f(x + \Delta x) - f(x)}{\Delta x}$$

Hence, given $f'(x)$ is the derivative of the function over argument x , the argument gain Δx is said to be the limit of the ratio of the function gain Δy to the argument gain Δx , optionally striving for zero. [1,2]

Let the body be acting in a straight line. It is clear that the sign of the path passed at each moment of time, corresponding to the value of the assignment, will be the yol temporal function, i.e.

$$S = f(t)$$

But this correspondence is Turlich in different motion; a second body can move more slowly if one body moves faster; while one body travels the same distance at the same time intervals, a second body can travel different distances at the same time intervals.

Methods

To characterize movement, a physical quantity called speed is introduced.

Example 1. Material point $S = \frac{4}{3}t^3 - t + 5$ moving by law. $t=2$ find a acceleration in seconds.[1]

Act 1. We find the speed:

velocity V is the first derivative of the path in time:

$$v = \frac{ds}{dt}$$

$$v = \frac{d}{dt} \left(\frac{4}{3}t^3 - t + 5 \right)$$

We get:

$$v = \frac{4}{3}3t^2 - 1 = 4t^2 - 1$$

Act 2. We find the acceleration:

Acceleration a is the time derivative of velocity:

$$a = \frac{dv}{dt}$$

$$v = \frac{d}{dt}(4t^2 - 1)$$

$$a = 8t$$

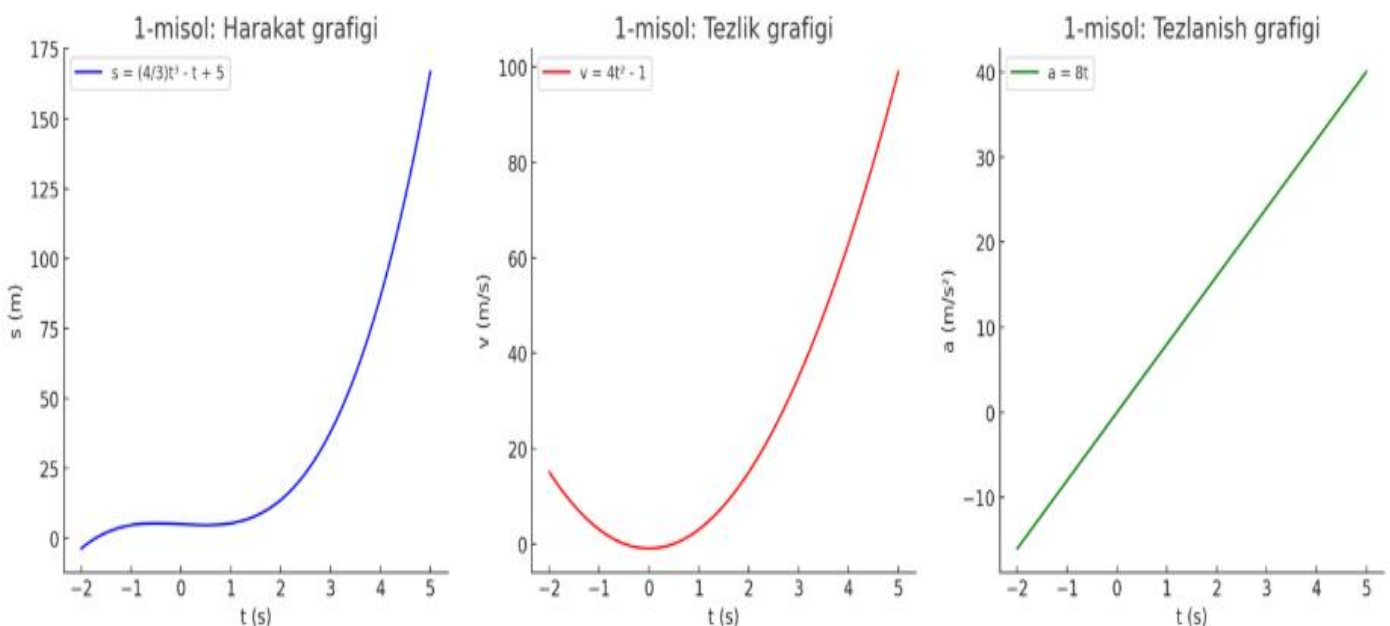
Act 3. calculation for $t = 2$ seconds:

$$a(2) = 8(2) = 16 \text{ m/s}^2$$

Graph.1) The Movement will hang up, being a curve

2) the speed changes in a quadratic form

3) and acceleration is linear, that is, it changes over time.



Example 2. The body was dropped vertically from a height of 10 m with a starting speed of 20 M/s. How many t seconds later will the body be at an altitude of x ? Determine the speed and acceleration of movement. [1]

Step 1 drawing up the equation of Motion:

The body is thrown vertically upward, so its movement is associated with the movement of free fall. The equation of Motion looks like this:

$$x(t) = x_0 + v_0 t - \frac{1}{2} g t^2$$

here:

- $x_0 = 10 \text{ m}$ (initial height),
- $v_0 = 20 \text{ m/s}$ (starting speed),
- $g = 9.8 \text{ m/s}^2$ (free fall acceleration).

Thus, the equation is written as:

$$x(t) = 10 + 20t - 4.9t^2$$

Step 2 determining the speed through the derivative:

Velocity $v(t)$ is the time derivative of altitude:

$$v(t) = \frac{d}{dt} (10 + 20t - 4.9t^2)$$

We get:

$$v(t) = 20 - 9.8t$$

Step 3 determining acceleration by derivative:

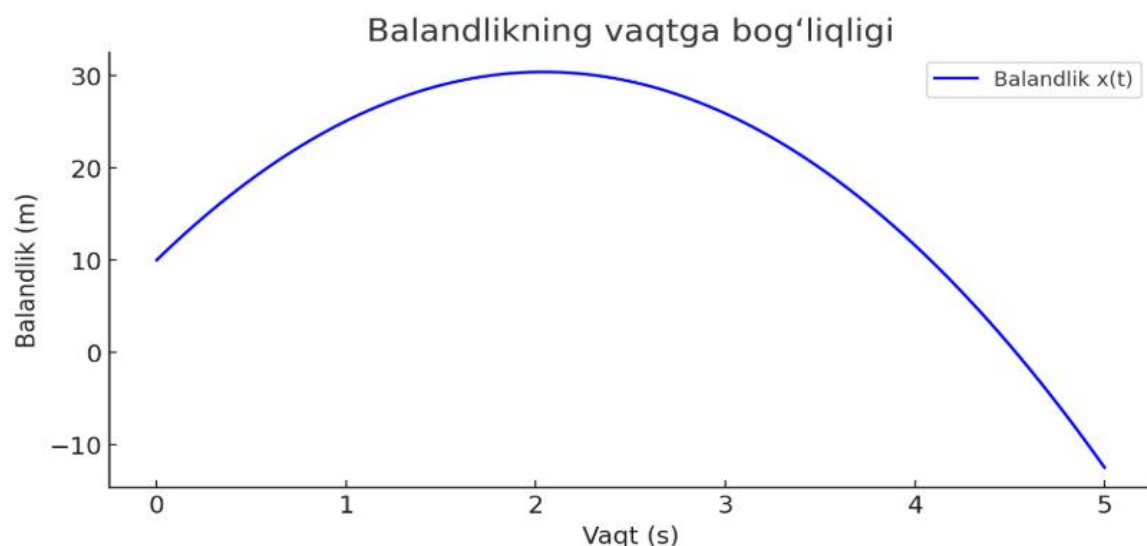
Acceleration $a(t)$ is the time derivative of the velocity:

$$a(t) = \frac{d}{dt} (20 - 9.8t)$$

Here:

$$a(t) = -9.8$$

Graph.1. The height Graph $x(t)$ is the initial height of 10 m, with the object first



rising and then falling down.



2. Acceleration graph $a(t)$ – regular -9.8 m/s^2 which indicates the acceleration of gravity.



Along the moving cross section of the fluid flow moving in a flat stable laminar order, it is the velocity distribution.

Results

We get acquainted with the flow of fluid moving under pressure in a cylindrical pipe of Radius r_0 . We show the Avs epic of the AV cross section and try to determine the Avs curvature equation. To do this, we define a cylindrical set of radius r within the moving fluid. [3]

- 1) for this set, the friction voltages of the circuit in the side surfaces can be written in two different ways:

$$\tau = \gamma R J = \gamma \frac{r}{2} J$$

in this case, the hydraulic radius of the set under consideration is:

$$R = \frac{\omega}{\chi} = \frac{\pi r^2}{2\pi r} = \frac{r}{2}$$

- 2) Based on Newton's law:

$$\tau = \eta \left| \frac{du}{dn} \right| = -\eta \frac{du}{dr}$$

In the selected direction (r) (See Figure 1) $\frac{du}{dn}$ negative.

Solving expressions together,

$$\gamma \frac{r}{2} J = -\eta \frac{du}{dr}$$

or

$$du = -\frac{1}{2} \frac{\gamma}{\eta} J r dr$$

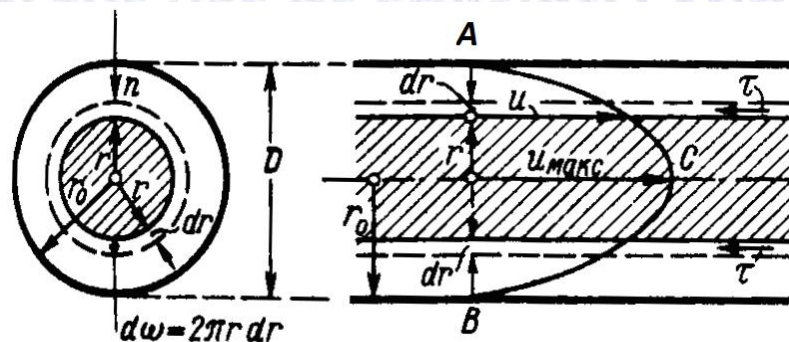


Figure 1. Flat stable of liquid in a circular pipe movement in laminar order

By integrating this equation, we obtain:

$$u = -\frac{\gamma}{4\eta} Jr^2 + C$$

Since at $r = r_0$ and $u = 0$ for the initial condition we find:

$$0 = -\frac{\gamma}{4\eta} Jr_0^2 + C$$

in this

$$C = \frac{\gamma}{4\eta} Jr_0^2$$

we put the expression in the equation:

$$u = \frac{\gamma}{4\eta} J(r_0^2 - r^2)$$

where, J is the peizometric slope.

Hence, ASV is, according to the expression, a parabola. By placing the magnitude $r=0$ on the expression, we can write the maximum value of the velocity;

$$u_{\text{max}} = \frac{1}{4} \frac{\gamma}{\eta} Jr_0^2$$

Modeling erosion processes.

When the flow of water affects the surface of the Earth, an erosion process occurs. With an increase in the flow rate, the degree of soil washing also increases. The graph shows that the rate of erosion depends on the rate of water flow, which plays an important role in the design of hydraulic structures and the maintenance of agricultural land productivity. Soil erosion also increases as the flow rate increases. This is explained in terms of Shear Stress Theory.[4]



Discussion

The derivative and its practical application are important not only for the theoretical part of mathematics, but also for engineering and Natural Sciences. In this article, applications of the derivative in physics and mathematics were considered within the framework of processes related to hydraulic structures. It was shown that with the help of the derivative, it is possible to model the speed of water flow, changes in hydrostatic pressure and erosion processes. These methods are considered important in the field of hydraulic engineering and are widely used in the management of Water Resources, the design of structures and the understanding of hydraulic processes. The use of the derivative contributes to a deep understanding of the laws of hydraulics and hydromechanics.

Conclusion

In the end, we can conclude that even if we work on a physical path and work on a mathematical path, the result turned out to be the same. This is due to the fact that even if we work these examples with the help of physical formulas, we will still be forced to take the derivative. The physical path is also correct, but let's not even say that physics is built on mathematics, we still use mathematical formulas even when we work on a physical path.

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