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APPLICATION OF DIFFERENTIAL CALCULUS IN PRACTICAL PROBLEMS

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Abstract
This article covers the application of differential calculus in practical problems. It provides specific examples in the fields of finding extreme values of functions, optimization, physics (movement, velocity, projectile range), economics (maximizing profit, minimizing costs), and geometry (minimizing surfaces). Each example is explained with step-by-step solutions, which shows the practical significance of theoretical knowledge.

Keywords: Differential calculus, derivative, extremum, optimization, maximum, minimum, practical problems, physics, economics, geometry, cylinder, projectile, profit, area, cost, speed.

Introduction

Differential calculus is one of the important sections of mathematical analysis, which is widely used in solving problems such as finding the rate of change of a function, values of extremum (maximum and minimum), and determining the inflection points of the function graph. Differential calculus is an indispensable tool, especially in optimization problems, i.e., in finding the largest or smallest value of a quantity under given conditions. The theory of differential calculus has fundamental importance in physics, engineering, economics, biology, and many other fields.

1. Optimization problems. Optimization problems are one of the most widespread areas of application of differential calculus. In problems of this type, it is necessary to determine the maximum or minimum value of a function (for example, cost,

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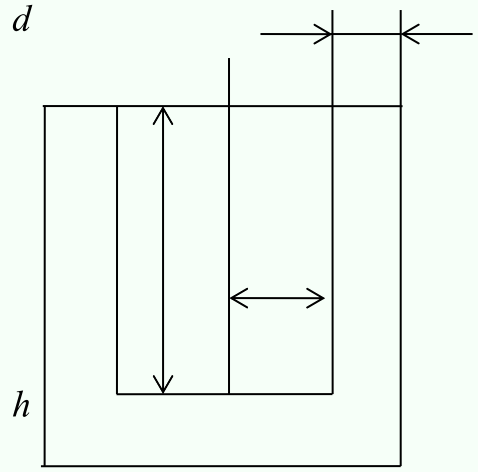
profit, area, volume, etc.). For this, the derivative of the function is taken and the derivative is set equal to zero, and the found critical points are checked.
V_0dLet it be necessary to construct an open cylindrical reservoir with a volume. Its material has thickness.
What should be the dimensions of the reservoir, i.e., the radius and height of its base, so that the material consumption during its construction is minimal?
xhSolution: We denote the radius of the base of the inner cylinder by, and the height by. Then:

$$V = \pi(x+d)^2 d + \pi[(x+d)^2 - x^2]h = \pi d(x+d)^2 + \pi h(2xd + d^2)$$



On the 2nd side, by condition

$$V_0 = \pi x^2 h, \qquad h = \frac{V_0}{\pi x^2}.$$

Then:

$$V = \pi d = (x+d)^2 + \frac{\pi V}{\pi x^2} \cdot (2xd + d^2) = \pi d(x+d)^2 + \frac{2V_0}{x} + \frac{V_0 d^2}{x^2}.$$

$x > 0$Let's check this function for an extremum. For this, we take the derivative.

$$V'(x) = 2\pi d(x+d) - \frac{2V_0 d}{x^2} + \frac{2V_0 d^2}{x^2} = \frac{2d(x+d)(\pi x^3 - V_0)}{x^3}$$

$$V'(x) = 0$$

$$2d(x+d)(\pi x^3 - V_0) = 0.$$

$x = \sqrt[3]{\frac{V_0}{\pi}}$This equation has a unique positive solution.

hNow let's determine the value of.

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$$h = \frac{V_0 \cdot \sqrt[3]{\pi^2}}{\pi \cdot \sqrt[3]{V_0^2}} = \sqrt[3]{\frac{V_0}{\pi}} = x.$$

$x = h = \sqrt[3]{\frac{V_0}{\pi}}$So,.

2. Problems of motion and velocity. Differential calculus is widely used in physics for analyzing motion and calculating velocity and acceleration. The position function of an object can be used to determine velocity (first derivative) and acceleration (second derivative).

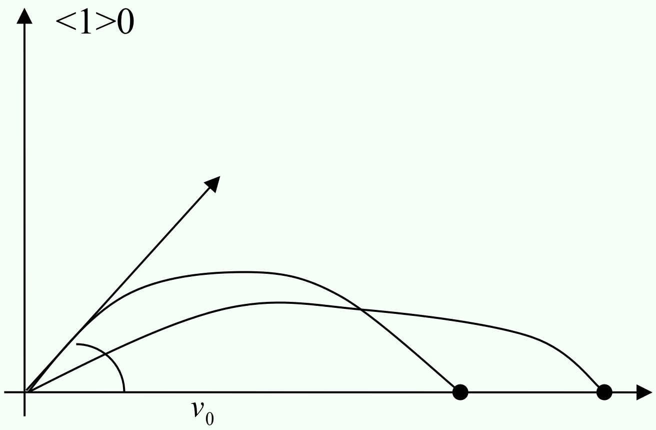
$\varphi v_0 R = OA$2-misol. Gorizontal burchak bilan qiyalatib qo‘yilgan to‘pdan boshlang‘ich tezlik bilan otilgan o‘qning bo‘shliqda uchish uzoqligi

$$R = \frac{v_0^2 \sin 2\varphi}{g}$$

At a given initial velocity, what angle should the arrow's flight distance be greatest?

$v_0 R\varphi$Solution:

y



$OA = Rg - R - \varphi 0 \leq \varphi \leq \frac{\pi}{2}$Consequently, the function has a maximum at the value.

$$R' = \frac{v_0^2 \cos 2\varphi}{g}, \frac{v_0^2 \cos 2\varphi}{g} = 0, \cos 2\varphi = 0, \varphi = \frac{\pi}{4};$$

$$R'' = -\frac{4v_0^2 \sin 2\varphi}{g}, \qquad R''\Big|_{x} = \frac{\pi}{4} = \frac{4v_0^2}{g} < 0.$$

$\varphi = \frac{\pi}{4}$Rmaximum value.

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$$R\Big|x = \frac{\pi}{4} = \frac{v_0^2}{g}$$

The function has values at the endpoints of the interval.

$R\left[0; \frac{\pi}{2}\right] R\big|\varphi = 0 = 0, R\Big|\varphi = \frac{\pi}{2} = 0$Consequently, the value is the largest value of the function.

$R = \frac{v_0^2}{g}$R<1>3. Differential calculus in economics.

Example 3. Maximizing profit in product manufacturing.

3-misol. Mahsulot ishlab chiqarishda foydani maksimallashtirish.

$qR(q) = 100q - 0.5q^2 C(q) = 10q + 1000$**Problem statement:** An enterprise produces a quantity of products. Let be the function of total revenue from product sales and the function of total costs. Find the amount of product that maximizes the company's profit.

$P(q)$**Solution:** The profit function is found by subtracting the expenditure function from the revenue function:

$$P(q) = R(q) - C(q) = (100q - 0.5q^2) - (10q + 1000)$$

$$P(q) = 100q - 0.5q^2 - 10q - 1000$$

$$P(q) = -0.5q^2 + 90q - 1000.$$

$P(q)q$Foydani maksimallashtirish uchun funksiyasining bo‘yicha hosilasini olamiz va uni nolga tenglashtiramiz:

$$P'(q) = (-0.5q^2 + 90q - 1000)'_q = -q + 90$$

$P'(q) = 0$Now let's check whether the function has a maximum at this critical point using the second derivative:

Since @@5, the profit function has a maximum at the value.

$$-q + 90 = 0$$

$$q = 90$$

<1>Thus, to maximize profit, the enterprise must produce

$$P''(q) = (-q + 90)'_q = -1.$$

$P''(q) = -1 < 0q = 90$Maximum profit:

Conclusion. Differential calculus is not only a mathematical theory, but also an important practical tool for solving various problems in real life. The examples considered above show that with the help of derivatives it is possible to effectively solve optimization problems, such as minimizing material consumption,

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maximizing flight range, or increasing profit. These methods allow us to find the best solutions, analyze processes, and make accurate forecasts in many areas, from engineering to economics. The universal application of differential calculus confirms its fundamental importance in science and technology.
References:

$$P(90) = -0.5 \cdot (90)^2 + 90 \cdot (90) - 1000$$
$$P(90) = -0.5 \cdot (8100) + 8100 - 1000$$
$$P(90) = -4050 + 8100 - 1000 = 3050$$

Xulosa. Differensial hisob nafaqat matematik nazariya, balki real hayotdagi turli masalalarni hal qilishda muhim amaliy vosita hisoblanadi. Yuqorida koʻrib chiqilgan misollar shuni koʻrsatadiki, hosilalar yordamida optimallashtirish masalalarini samarali yechish, masalan, material sarfini minimallashtirish, parvoz masofasini maksimallashtirish yoki foydani oshirish mumkin. Bu usullar muhandislikdan tortib iqtisodiyotgacha boʻlgan koʻplab sohalarda eng yaxshi yechimlarni topish, jarayonlarni tahlil qilish va aniq bashoratlar qilish imkonini beradi. Differensial hisobning universal qoʻllanilishi uning fan va texnikadagi fundamental ahamiyatini tasdiqlaydi.

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