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ON WAYS TO BUILD IMMUNITY AGAINST HYBRID WARFARE IN CADETS THROUGH TEACHING HIGHER MATHEMATICS

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Abstract
This article discusses the issue of forming intellectual immunity against hybrid wars and cadets against such wars as an example of teaching higher mathematics.

Keywords: Hybrid warfare, bacteria, bacteriological weapons, nuclear weapons, explosives, higher mathematics, function, exponent, differential equation, intellectual immunity, practical skills.

Introduction

Since the emergence of man, various conflicts have arisen in the sharing of material goods above and below the earth for their own benefit. As a result, the world has been repeatedly divided and wars have occurred.

When we imagine war, most people probably see scenes from films about the Second World War.

Modern military science and practices are fundamentally different from our views on war presented above. The information disseminated in the media shows that modern wars are being carried out in completely different forms and methods.

Recently, the concept of hybrid warfare has become increasingly common. This war is also called the 4th generation war. Currently, these types of warfare are being tested in practice on real battlefields, between states and similar structures. Hybrid warfare, by its nature, is a tactic used to achieve a specific strategic goal. Hybrid warfare can have varying degrees of activity. Military forces, especially specially trained forces, actively or passively participate in it. In this type of war, they use the most terrible atrocities and all means of force that can affect the ideas, thinking, and spiritual world of a person.

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According to Russian politicians, hybrid war is not a new type of war, but a type of war that is currently being fought not only with guns and tanks, but also with propaganda, disinformation and economic pressure from political forces on the enemy. In addition, hybrid war is the use of special services in enemy territory to lure them into their traps and disrupt the state's governance system.

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Especially in recent years, there has been a lot of information on the Internet about some major countries conducting hybrid warfare on the territory of other countries in order to achieve their strategic goals. Let's first dwell on some thoughts on the concept of "hybrid warfare" and analyze it with examples.

HYBRID WARFARE is a term introduced by the United States at the end of the 20th century to describe a military strategy that includes regular wars, small wars, and cyberwars.

The term “hybrid warfare” is also used by some politicians to describe attacks using nuclear, biological, and chemical weapons, improvised explosive devices, and information warfare. This approach to conflict is considered another form of warfare.

In this article, we would like to consider the ways of forming immunity against such wars by strengthening the intellectual immunity of cadets, taking into account the use of nuclear, biological and chemical weapons in hybrid wars, on the example of teaching higher mathematics.

As we know, bacteriological (biological) weapons are special combat weapons equipped with biological agents and equipment for their application. They are used to cause massive damage to enemy manpower, agricultural animals and plants, and in some cases to render weapons, military equipment, and parts of equipment unusable.

Bacterial growth. Anaerobic and aerobic bacteria have different ways of reproduction. Oxygen is necessary for the reproduction of aerobes. For anaerobes to multiply, it is necessary to create an oxygen-free environment. Bacterial growth is usually carried out in an environment of pN=7...7.5 at 36...40oC.

Some bacteria multiply in proportion to their quantity (mass, number of molecules or volume). Let the number of bacteria (N) or their weight (P), volume (V) be directly proportional to the k-proliferation coefficient. Let k_1 be the coefficient proportional to N, which represents the effects that resist the multiplication of bacteria, killing them (destruction). Let the initial number of bacteria N, its increase to the maximum value M, and then the decrease to the initial number N depend on the time t. If it is known that the bacteria produce toxins from the time of multiplication, then the production of toxins is also directly proportional to N and is denoted by k_2.

Solution. Let's define the amount of poison as x and construct the following system of differential equations according to the conditions of the problem.

$$\begin{cases} \frac{dN}{dt} = kN - k_1 Nx, \\ \frac{dx}{dt} = k_2 N. \end{cases} \quad (1)$$

In this system of differential equations (1), the rates of bacterial growth and toxin production, dN/dt and dx/dt, respectively, are related to each other. The equations in the system of differential equations (1) are related to each other, and we obtain the following differential equation:

$$\frac{dN}{dx} = \frac{k}{k_2} - \frac{k_1}{k_2} x \quad (2)$$

By integrating both sides of the resulting equation (2) with respect to x, the relationship between the number of N-bacteria and the coefficients (k,k_1,k_2) and the amount of poison produced is obtained.

$N = \frac{k}{k_2}x - \frac{k_1}{2k_2}x^2 + C$ (3)

If at $x = 0$ and $N = 0$ then ideally (which is not possible in real life) C_1 will also be zero. In this case, the relationship between the number of bacteria and the amount of poison is determined by the formula

$N = bx - ax^2$ (4)

where $\frac{k}{k_2} = b, \frac{k_1}{2k_2} = a;$

$y = N(x)$ is the graph of a parabola, which consists of a parabola with the origin and the point $A\left(\frac{b}{a}; 0\right)$, the axis of symmetry of which is parallel to the OY axis, and the vertex $O_1\left(\frac{b}{2a}; +\frac{b^2}{4a}\right)$.

Thus,

$N_{max} = M = \frac{b^2}{4a} = \frac{k^2 \cdot 2k_2}{4k_2^2 \cdot k_1} = \frac{k^2}{2k_1k_2}$ (5)

Now let's find the dependence of the number of bacteria on time t. To do this, we transform equation (4) into the form $ax^2 - bx + N = 0$ and solve it with respect to x:

$x_{1,2} = \frac{b}{2a} \pm \sqrt{\frac{b^2}{4a^2} - \frac{N}{a}}$ (6)

In order to express x in terms of N, we substitute this expression (6) into the first equation of the system of equations (1), then

$\frac{dN}{dt} = kN - \frac{k_1b}{2a}N \mp k_1N\sqrt{\frac{b^2}{4a^2} - \frac{N}{a}}$ (7)

Putting formulas (5) and (6) into (7) and after some simplifications

$\frac{dN}{dt} = kN - \frac{2abkN}{2a} \mp 2a\frac{k}{b}N\sqrt{\frac{b^2}{4a^2} - \frac{N}{a}},$

$\frac{dN}{dt} = \mp 2kN\sqrt{1 - \frac{N}{M}}$ (7′)

We derive (7'). It is clear that this is a differential equation with differentiable variables (with respect to N and t). If we separate the variables, we get the following expression

$\frac{dN}{N\sqrt{1-\frac{N}{M}}} = \mp kdt$ (8)

Let's solve this integral by substituting $\sqrt{1 - \frac{N}{M}} = y$.

Differentiating both sides of this expression $N = M(1 - y^2)$ gives

$dN = -2Mydy$.

Therefore, $\mp kdt = -2\int \frac{dy}{1-y^2} = ln\left|\frac{1-y}{1+y}\right| + C_1$

$\mp kdt = ln\left|\frac{1-y}{1+y}\right| + C_1$ C_1- is arbitrarily constant.

If we put the initial condition $N = M$ into this equation at $t = 0$, we obtain the partial integral $C_1 = 0$:

$$\frac{1-y}{1+y} = e^{\mp kt}$$

If we find y from the last equation, we obtain the hyperbolic tangent (thx).

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$y = \frac{e^{\mp\frac{kt}{2}} - e^{\pm\frac{kt}{2}}}{e^{\mp\frac{kt}{2}} + e^{\pm\frac{kt}{2}}}$ or $y = \pm th\frac{kt}{2}$;

Going back to the previous quantities N and M, we derive this equation:

$$\sqrt{1 - \frac{N}{M}} = \pm th\frac{kt}{2}$$

We square both sides of this and solve for N

$N = M(1 - th\frac{kt}{2})$ or $N = \frac{M}{ch\frac{kt}{2}}$ (9)

We create the resulting theoretical formula.

In short, bacteria multiply and die according to formula (9).

If the condition $t = 0$ is imposed on formula (9), the hyperbola is equal to one, and the number of bacteria reaches its maximum value, that is, $N = M$.

This means that the bacteria reach their initial value, as in the condition of the problem.

So we conclude that bacteria will never disappear, because the graph of the hyperbolic cosine lies in the upper part of quadrants I and II of the Cartesian coordinate system (Figure 1).

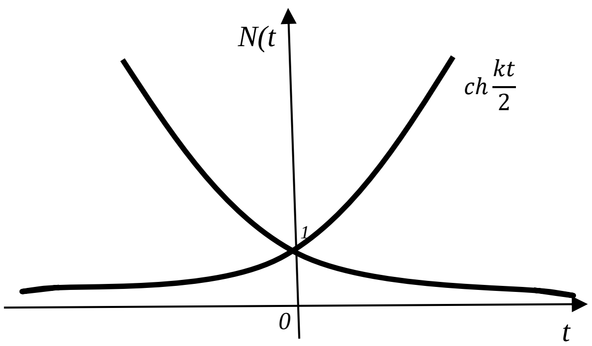

Figure 1. Relationship between bacterial population and survival time

The life span of bacteria varies according to the hyperbolic cosine law, which is explained by the fact that hyperbolic cosine is never zero.

One of the most pressing problems today is the global spread of coronavirus (covid-19), which can also be considered a form of hybrid warfare. It is known from experiments that the reproduction rate of coronavirus (covid-19) is directly proportional to the amount of food (the number of people carrying it), so let's consider how to solve the problem of how long it will take for the number of viruses to increase m times from the initial state using mathematical tools.

If $x(t)$ is the amount of virus or bacteria at time t, and $x(0) = x_0$is its initial amount, we construct a differential equation for the rate of spread of coronavirus (covid-19) over time.

$$\frac{dx}{dt} = kx; k > 0.$$

We solve the differential equation using the method of substitution of variables

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$$\int \frac{dx}{x} = k \int dt; \Longrightarrow lnx = kt + lnC: lnx = lnCe^{kt}: \ x(t) = Ce^{kt}$$

Using the initial condition $x(0) = x_0 = C;\ \ x(t) = x_0 e^{kt}$. Suppose that at time T the amount of virus has increased by m times,

$$x(T) = mx_0 = x_0 e^{kT} \Longrightarrow m = e^{kT}, \qquad lnm = kT \Longrightarrow T = \frac{lnm}{k}$$

the empirical formula that shows that the virus has multiplied m times from the initial state is obtained. By substituting a number for m in the last formula, we can obtain statistical data relative to the initial state. This formula is used to determine the radiation produced by an atomic bomb explosion, the decay of radioactive elements in nuclear power plants, the amount of toxic substances in the environment, and the harmful effect (activation level) of chemical and biological weapons. (In most cases, these formulas are given to cadets without being derived, but ready-made).

By teaching our cadets to solve such applied problems in higher mathematics, we not only develop applied thinking in them, but also develop intellectual immunity to any foreign ideas. Our cadets' interest in science increases, their worldview expands, and they develop their own views and evaluation methods for current events.

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