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NEW METHODS OF TEACHING LINEAR ALGEBRA TO STUDENTS OF CURRENT TECHNICAL EDUCATION

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Annotation. **V state rassmatrivayutsya voprosy adaptatsii obucheniya "Lineynoy algebre" v vysshih teknicheskih uchebnyx zadevaniyax k sovremennym injenernym trebovaniyam. For elimination A new approach based on the principles of STEAM and digital technology is presented in the traditional method of abstraction and mechanical calculation. It is a concrete example of a demonstrated methodology of geometrical visualization, mathematical concepts, integration with engineering models, electrical engineering and vibrational analysis, as well as linear Diophantine equations. Obsveshchena role program Python (NumPy) and MATLAB and formation of practical skills of students.**

Key words: Linear algebra, STEAM, higher technical education, engineering model, Diophantine equations, Python , MATLAB, visualization.

Аннотация. **В статье рассматриваются вопросы адаптации обучения «Линейной алгебре» в высших технических учебных заведениях к современным инженерным требованиям. Для устранения абстрактности и механических вычислений традиционного метода предложен новый подход, основанный на принципах STEAM и цифровых технологиях. На конкретных примерах продемонстрирована методика геометрической визуализации математических понятий, их интеграция с инженерными моделями электротехники и анализа колебаний, а также с линейными Диофантовыми уравнениями. Освещена роль программ Python (NumPy) и MATLAB в формировании практических навыков студентов.**

Ключевые слова: Линейная алгебра, STEAM, высшее техническое образование, инженерные модели, Диофантовы уравнения, Python, MATLAB, визуализация.

INTRODUCTION. Mathematics science supreme of education almost all in the directions Unfortunately , at present in the auditoriums from mathematics knowledge demand at the level not been students They are also in the audience . knowledge to take hope with are sitting . Lecture and practical lessons demand at the level to knowledge has was students to master to receive possible . From mathematics there is textbook and training the manuals are also sufficient knowledge level student for intended . In mathematics mainly laws and regulations based on expressions one from the look other to look is replaced . Exactly this places knowledge low- level student for you don't understand will be and their new knowledge to master makes it difficult .

Economy and technique direction students for mathematician knowledge mainly them in the future work in the activity support new information in receiving Present tense developed software tools complicated mathematician operations numerical and symbolic in appearance done increasing is giving . Years using even short multiplication formulas without knowing , " instead of " What is " put " ? that without understanding complicated mathematician operators executable expressions on at hand action different without doing it necessary results olsh possible .

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Now mathematics professors own science program in the making which to the direction intended further more importance give need it . direction experts with in cooperation working performances to the goal is appropriate . From students mainly to the directions suitable mathematician issue to be put , it solution to do method , result to take and the result analysis to do demand to do important . They in hand mathematician operations complete even if it doesn't matter essence to know , to know solution methods about for information has to be , the result right I will evaluate. to receive necessary . Therefore suitable accordingly mathematics from science study program , textbook and training manuals mathematics from the field other directions for modern computer programs opportunities with harmonized without again create current from issues is considered .

Modern engineering and technologies in the century supreme technique study fundamental sciences , in particular , linear algebra, in their countries teaching quality fundamentally update demand Artificial intelligence (AI), machine The rapid development of fields such as machine learning, big data analysis, robotics, and computer graphics has transformed linear algebra from a mere abstract mathematical apparatus into an everyday practical tool for engineers.

However , traditional education The methodology is often limited to teaching students only dry formulas, mechanical methods of calculating determinants, and proving abstract theorems. This raises the legitimate question for technical students : "How will this subject help me in my future engineering career?"

This of the article The goal is to propose a new approach to teaching linear algebra in technical higher education institutions based on STEAM (Science, Technology, Engineering, Art, Mathematics) principles, digital technologies, and applied engineering models, and to demonstrate its methodological foundations using examples and theorems. showing from giving consists of .

PROBLEMS OF TRADITIONAL EDUCATIONAL METHODOLOGY AND THE NEW PARADIGM

Far years during Linear algebra has been taught in the "classical" way - in the form of a chain of definitions, theorems, proofs and standard academic examples . For engineering students, this approach creates the following disadvantages:

1. Lack of geometric and practical imagination : Students cannot visually imagine dimensionless spaces or linear transformations.
2. a lot of time on mechanical calculations : A student spends 20-30 minutes finding the determinant of a 4x4 matrix or solving a system of linear equations (SLE) using the Gaussian method, but does not understand the essence of the process.
3. Disruption of interdisciplinary connections : The connection of matrix theory with electrical engineering, mechanics, or programming is explained late (in advanced courses) or not at all.

New approach conceptual foundation (STEAM integration)

In the new approach, the educational content is built on the principle of "From Problem to Theory, From Theory to Digital Solution." That is, the lesson begins with a real technical problem (for example, the movement of a robot manipulator or the analysis of an electrical circuit), then a mathematical model (matrix, linear system) is built to solve it, the theoretical part is studied, and it is implemented using modern software tools (MATLAB, Python).

GEOMETRIC AND METRIC REPRESENTATION OF LINEAR ALGEBRA

Visualizing mathematical concepts is essential for technically minded students. The basic concepts of linear algebra—vectors, linear spaces, and permutations—have geometric meaning.

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Vector space and Linear combination

Definition 1: If the operations of adding elements in *a set V and multiplying them by real numbers (scalars) R are defined and satisfy the 8 axioms of linear space, then the set V is called a vector (or linear) space.*

It is not effective to simply teach students these axioms. Instead , it is necessary to demonstrate the concepts of linear combination and spatial shell (Span) geometrically:

$$v = c_1v_1 + c_2v_2 + c_3v_3 + \cdots + c_nv_n$$

If two collinear not been $c_1$and $v_2$vectors, showing in dynamic graphics programs that the set of all their linear combinations forms a plane (2D space) on which these two vectors lie increases the effectiveness of the lesson.

MATRICES AND LINEAR TRANSFORMATIONS: PRACTICAL INTERPRETATION

Traditional in classes A matrix is taught as a rectangular table of numbers . In a new approach, a matrix is taught as a dynamic operator that transforms this space . interpretation will be done .

Linear permutations and their matrix form

Every How to multiply a matrix A by a vector x (Ax = y), and how to transform this vector from one state to another (stretch, rotate, reflect) is fundamental to engineering graphics and robotics.

Theorem 1 (Linear replacement matrix): *IfT*: $R^n \to R^m$ *linear replacement if , then every always so single A (mxn) size matrix there is it will be that all* $x \in R^n$ *for* $T(x) = A(x)$ *The relationship will be appropriate.*

Computer graphics and in class practical example

To explain to students what happens when matrices are multiplied, we will give an example of twisting objects in computer games.

Issue 1: Two measurable in space given coordinate the object (vector). per head relatively θmatrix of the angle rotation operator compose and $x = \begin{pmatrix}1\\0\end{pmatrix}$ vector $\theta = 90^o$Turn to degrees.

Solution : Geometric to the comments Therefore , the torsion matrix will have the following form:

$$R_\theta = \begin{pmatrix}cos\theta & -sin\theta\\ sin\theta & cos\theta\end{pmatrix}$$

In that case θWhen = 90 degrees:

$$R_{90} = \begin{pmatrix}cos90 & -sin90\\ sin90 & cos90\end{pmatrix} = \begin{pmatrix}0 & -1\\ 1 & 0\end{pmatrix}$$

Given a vector x We use this operator :

$$y = R_{90} \cdot x = \begin{pmatrix}0 & -1\\ 1 & 0\end{pmatrix}\begin{pmatrix}1\\0\end{pmatrix} = \begin{pmatrix}0*1+(-1)*0\\ 1*1+0*0\end{pmatrix} = \begin{pmatrix}0\\1\end{pmatrix}$$

a result, the OP reads the lying vector has shifted to the OY axis, that is, it has actually rotated 90 degrees. Through this example, the student sees the practical importance of matrix multiplication .

INTEGRATION OF DIOPHANTINE EQUATIONS AND MATRIX THEORY

Integrating elements of linear algebra with number theory, particularly Diophantine equations, is a unique part of a new approach to enriching fundamental mathematics in higher technical education . This develops students' logical thinking and the ability to solve Olympiad-level problems.

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Matrix in a way linear Solving Diophantine equations

A linear Diophantine equation is of the form ax + by = c , where a, b, c are integers and we are looking for integer solutions. The equation can be easily solved by expressing it in matrix form using Euclidean algorithm.

Theorem 3: For the Diophantine equation ax + by = c *to have a solution in integers, it is necessary and sufficient that the number c is divisible by the greatest common divisor (GCD) of a and b without remainder: GCD(a,b) | c.*

Problem: Find all integer solutions of the Diophantine equation 15x + 21y = 6 using matrix substitutions.

Solution :

Beginner unity replacement matrix to compose we get :

$$\begin{pmatrix} a & 1 & 0 \\ b & 0 & 1 \end{pmatrix} \rightarrow \begin{pmatrix} 15 & 1 & 0 \\ 21 & 0 & 1 \end{pmatrix}$$

Second from the line first the line let's separate $(S_2 - S_1 \rightarrow S_2)$:

$$\begin{pmatrix} 15 & 1 & 0 \\ 6 & -1 & 1 \end{pmatrix}$$

First from the line second line 2 times let's subtract ($S_2 - 2S_1 \rightarrow S_2$):

$$\begin{pmatrix} 3 & 3 & -2 \\ 6 & -1 & 1 \end{pmatrix}$$

We subtract the first row from the second row 2 times ($S_2 - 2S_1 \rightarrow S_2$):

$$\begin{pmatrix} 3 & 3 & -2 \\ 0 & -7 & 5 \end{pmatrix}$$

We found that EKUB (15, 21) = 3. The following relation follows from the first row of the matrix:

$$15 * (3) + 21 * (-2) = 3$$

Since we need the right side of the equation to be 6, we multiply the equation by

$15 * (6) + 21 * (-4) = 6$

This gives a particular solution: $x_0 = 6$, $y_0 = -4$.

General solution formula and as follows will be :

$$\begin{cases} x = 6 + \frac{21}{3}t = 6 + 7t \\ y = -4 - \frac{15}{3}t = -4 - 5t \end{cases} \quad (t \epsilon Z)$$

INTEGRATION OF DIGITAL EDUCATIONAL TOOLS AND SOFTWARE PACKAGES

The current engineer works with matrices of size 100x100 in practice . It is impossible to calculate them manually . Therefore, the new training concept requires that 30% of the weekly laboratory or practical training be spent on computer programs.

Using Python and the NumPy library

Teaching students how to perform matrix operations in the Python programming language builds their IT skills.

```
import numpy as np

# Declare a matrixA = np.array([[4, 2], [1, 3]])
```

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```
# Calculate eigenvalues and eigenvectorseigenvalues, eigenvectors = np.linalg.eig(A)

print("Eigenvalues:", eigenvalues)print("Eigenvectors:\n", eigenvectors)
```

Visualization in MATLAB

Using MATLAB students They can graphically see how space is deformed as a result of linear transformations . This reduces the level of abstraction of the subject and dramatically increases students' interest in the subject.

INTEGRATED EDUCATIONAL MATRIX (PEDAGOGICAL ANALYSIS)

Criterion	**Traditional methodology**	**A new approach (STEAM & Digital)**
Home goal	Memorizing formulas and standard calculations.	Visual understanding of concepts and application to engineering.
Calculation method	Only on paper and pencil, mechanical lessons.	Theoretical basis + Python/MATLAB applications.
Interdisciplinary dependency	Almost none, mathematics is taught separately.	Integrated with physics, electrical engineering, IT and robotics.
Student role	Listener, passive object.	A researcher is a problem-solving entity.

CONCLUSION . Higher technique education A new approach to teaching linear algebra in higher education institutions is a guarantee of enriching the content of lessons and expanding the scope of engineering and logical thinking of students.

the article shows , introducing geometric and visual interpretations into the teaching process, mathematical modeling of real engineering problems such as electrical circuits and mechanical vibrations, and integrating software dramatically increase the effectiveness of the lesson. This approach serves as a solid foundation for training future engineers and programmers who are competitive and proficient in modern technologies in higher technical educational institutions .

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