UDC 662.749.33

INVESTIGATION OF THE PERFORMANCE OF A LAPTOP REQUIRED FOR STUDENT LEARNING PROCESSES

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Abstract. This study analyzes the performance requirements of a laptop that are necessary for successful academic processes for students. It examines the fundamental components of a computer and software tasks, as well as analyzes power consumption, considering different types of loads.
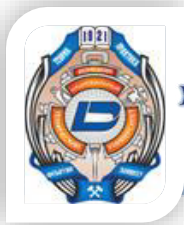
Keywords. Student, laptop, performance, academic process.

In today's world, laptops and other computer technologies have become an essential part of our lives. It is impossible to exist in the modern world without computers. People spend several hours every day interacting with them.

For students, laptops play a significant role in their daily lives, both academically and socially. They serve as educational tools, providing access to endless information, and also as a means of entertainment. In today's society, laptops perform several crucial functions for students:

- Facilitating communication with peers, teachers, and other people.

- Executing professional tasks related to learning and professional activities.

- Providing entertainment through activities like gaming and watching movies.

Any laptop with internet access can be used for communication purposes. However, this research does not focus on leisure activities, as they are not a primary concern for a student during the academic process. Instead, this study emphasizes the need for performing professional tasks while using a computer.

The aim of this research is to determine the optimal hardware configuration for a laptop that will allow students to effectively complete the required tasks during their academic process.
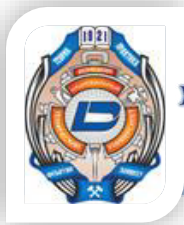
Laptop. Main components of a laptop

A laptop is a sophisticated electronic device that consists of numerous components. The performance of these components significantly affects the overall efficiency of the system. The main elements of a laptop include the central processing unit (CPU), the graphics processing unit (GPU), and the random access memory (RAM). These components directly determine the speed and performance of the device.

The CPU, also known as the "brain" of the laptop, ensures the smooth operation of the entire system. Its speed directly influences how quickly software code is processed, how the operating system functions, and how installed applications execute. The speed of the CPU has a direct impact on the performance of the laptop.

The GPU is responsible for processing and displaying images on a monitor. Its main function is to create visual content for users, but it can also perform computational tasks.

Random access memory (RAM) is essential for temporary data storage and transfer to the processor. It actively participates in storing temporary data and processing, relieving the processor and preventing excessive load during processing.

Software utilizes all these components, but different programs focus on specific components based on their requirements. Graphics-intensive tasks require a powerful graphics processing unit (GPU), while working with large amounts of data necessitates a high-performance central processing unit (CPU)
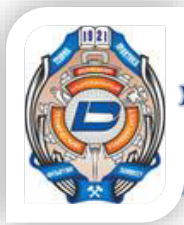
and a significant amount of RAM. Optimizing software is critical because the need for specific components depends on the nature of the tasks the program performs and the decisions developers make during implementation.

Mathematical model

Professional tasks for students vary depending on their field of study. To complete these tasks, specialized software is often required, which in turn requires specific hardware with certain performance capabilities. Software tools are organized by field of study and their minimum hardware requirements can be found in Table 1.

Table 1 – Program Names and Their Component Requirements

Program Name	Processor Requirement, Performance Index	Graphics Card Requirement, Performance Index	RAM Requirement, GB
Toolkit for a design student			
Adobe Photoshop 2023	1400	4000	8
Adobe Premier Pro CC 2023	4300	10000	8
Autodesk 3ds Max 2024	2400	4000	4
Adobe Illustrator 2024	1400	2000	4
A suite of programs for a programming student			
Visual Studio 2024	3000	2000	2
MS SQL	500	1	1
Active-HDL	2500	1500	4
Matlab R2023b	3000	1000	4
The set of programs utilized by all students			
MS Office	1500	800	2
Веб-браузер	700	1500	2
Discord	1000	1000	2

The formula for calculating software requirements coverage in computer components B, expressed as a percentage, is referred to as Formula 1:

$$B = \left(\prod_i^N \frac{P_i}{R_i} \right) * 100\% \,, \tag{1}$$

Where:

N – the set of components;

M – the set of concurrently running programs;

Pi – the performance of the i-th component;

Ri – the requirement of programs for the i-th component. In the calculation, the sum of all requirements of concurrently running programs is taken, according to Formula 2:

$$Ri = \sum_j^M R_{ji}, \tag{2}$$

Where:

Rji – represents the requirement of the j-th program for the i-th component, taken from Table 1.

This allows for calculating the coverage of component needs to support student academic activities with various sets of concurrently running software.

Experimental Research

1. A set of software tools for a student programmer running simultaneously includes:

- AutodActive-HDL;
- Visual Studio 2024;
- Matlab R2023b;
- MS Office;
- Веб-браузер;
- Discord.
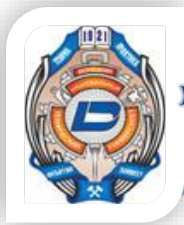
According to the set of programs:

$$R_{CPU} = 3000 + 2500 + 3000 + 1500 + 700 + 1000 = 11700;$$

According to the processor performance table [1], the requirements can be met by the processors listed in table 2.

Table 2 – Suitable processors for a design student according to the set of programs

Central Processing Unit	Performance index
Intel Core i5-13420H	11821.17
AMD Ryzen 7 5800H	11731.11

$$R_{GPU} = 2000 + 1500 + 1000 + 800 + 1500 + 1000 = 7800;$$

According to the graphics card performance table [2], the following graphics cards listed in table 3 can meet the specified requirements.
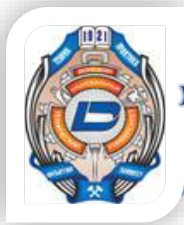
Table 3 – Suitable graphics cards for a design student according to the software suite.

Graphics Card	Performance index
NVIDIA GeForce MX350	8122
AMD Radeon R9 M385X	7953

$$R_{RAM} = 2 + 4 + 4 + 2 + 2 + 2 = 16.$$

It will be noted that the experimental notebook has 16 gigabytes of RAM:

$$P_{RAM} = 16;$$

Based on all the established parameters, we can conduct a calculation to assess how well this configuration can meet the needs of the student in completing the assigned programs.

For a pair of an Intel processor and Nvidia graphics card:

$$B = \left(\frac{11821.17}{11700} * \frac{8122}{7800} * \frac{16}{16}\right) * 100\% = 105{,}21\%$$

For a pairing of an AMD processor and AMD graphics card:

$$B = \left(\frac{11731.11}{11700} * \frac{7953}{7800} * \frac{16}{16}\right) * 100\% = 102{,}23\%$$

Based on the provided information, it can be concluded that the combination of Intel + NVIDIA and AMD + AMD provides a comprehensive solution for meeting the learning needs of students.

Depending on various factors such as CPU and GPU performance, there is a diverse range of possible outcomes when using the proposed set of software tools. This is illustrated in Figure 1:
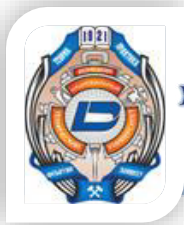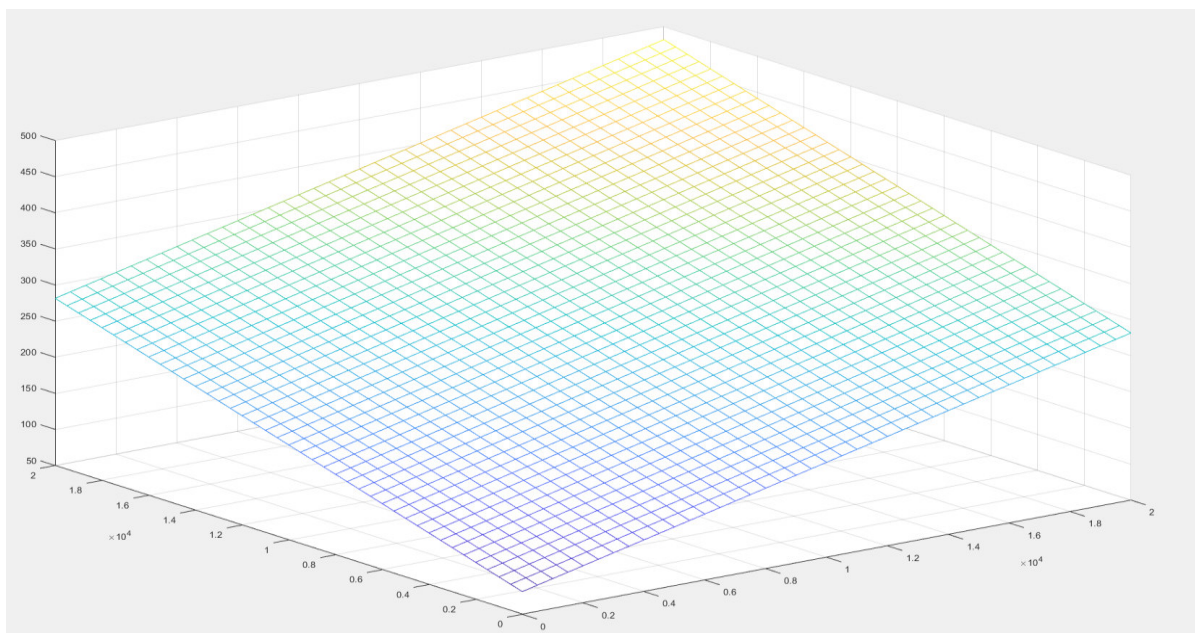

Figure 1 – Graphic Modeling for a Student Programmer

2. A suite of software tools for a design student, launched simultaneously, includes the following:

- Adobe Photoshop 2023

- Adobe Premier Pro CC 2023

- MS Office;

- Веб-браузер;

- Discord.

According to the set of programs:

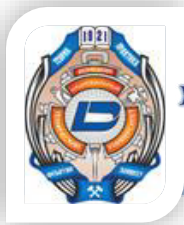$$R_{CPU} = 1400 + 4300 + 1500 + 700 + 1000 = 8900;$$

According to the processor performance table [1], the following processors listed in table 4 can meet the specified requirements.

Table 4 – Suitable processors for a student programmer according to the set of programs

Central Processing Unit	Performance index
Intel Core i9-10880H	8900.05
AMD Ryzen 5 PRO 5650U	9012.42

$$R_{GPU} = 4000 + 10000 + 800 + 1500 + 1000 = 17300;$$

According to the GPU performance chart [2], the requirements can be met by the following graphics cards listed in Table 5.

Table 5 – Suitable graphics cards for a programming student according to the set of programs

Graphics Card	Performance index
NVIDIA T550M	17445
AMD Radeon RX 5300M	18685

$$R_{RAM} = 8 + 8 + 2 + 2 + 2 = 22$$

When an experimental laptop has 32 gigabytes of RAM, it will be considered.

$$P_{RAM} = 32$$

Based on all the provided parameters and characteristics, it is possible to assess how well this configuration meets a student's needs when using specific programs.
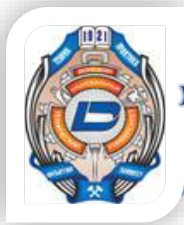
For a combination of an Intel processor and Nvidia graphics card:

$$B = \left(\frac{8900.05}{8900} * \frac{17445}{17300} * \frac{22}{32}\right) * 100\% = 69{,}33\%$$

For a pair, an AMD processor and an AMD graphics card:

$$B = \left(\frac{9012.42}{8900} * \frac{18685}{17300} * \frac{22}{32}\right) * 100\% = 75{,}19\%$$

Given the provided information, we can conclude that the selected configurations of Intel + NVIDIA and AMD + AMD only partially meet the student's requirements during the learning process.

In the context of the given set of software tools, and with changes to parameters such as processor and graphics card performance, different levels of need satisfaction can be observed, as shown in Figure 2.
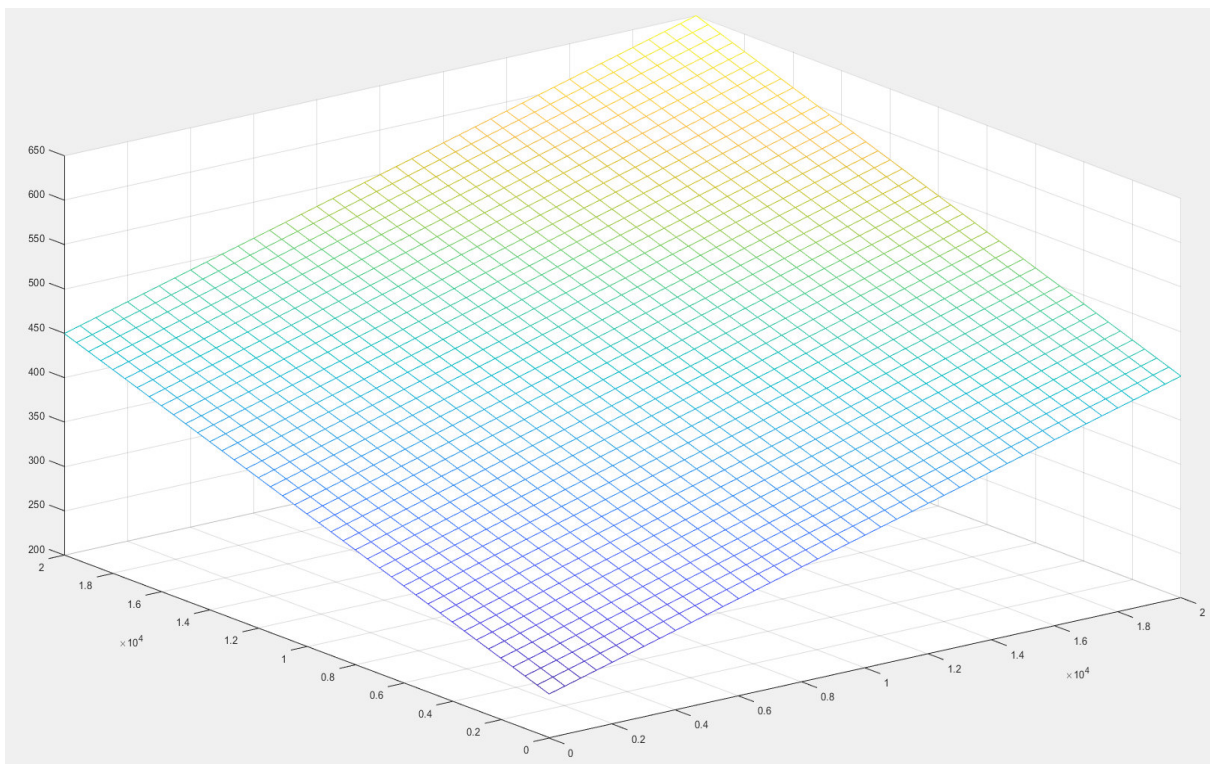

Figure 2 – Graphic Modeling for a Computer Science Student

Conclusion. Based on the modeling and calculations conducted, optimal computer components have been identified that can effectively meet the needs of modern students in various fields of study. The research has also confirmed the assertion that each specialty and program used in the educational process requires specific hardware tailored to its unique requirements. For example, for design students, a powerful graphics card and increased RAM capacity are crucial, while programming students require a more powerful processor.