COMPUTER MATHEMATICS TOOLS AS A TOOL IN THE STUDY OF DIFFERENTIAL EQUATIONS

Kużel Sergiusz
Dr. Hab., Prof., Head of Department of Mathematical Analyses and Applications, AGH University Kraków,
kuzhel@agh.edu.pl
Grod Ivan
Doctor of Physical and Mathematical Sciences, Professor Department of Mathematics and Methods of its Teaching,
Ternopil Volodymyr Hnatiuk National Pedagogical University,
grodiv@tnpu.edu.ua

The paper investigates the effectiveness of using computer mathematics tools in the process of studying differential equations in higher education institutions. Emphasis is placed on the role of computer modeling, visualization, and numerical problem solving as tools for improving the quality of students' mathematical training. Particular attention is paid to the Python programming language and its libraries (NumPy, SciPy, SymPy, Matplotlib), which provide broad opportunities for implementing mathematical models.

In modern conditions of education development, the need for a deeper understanding of the subject material through active interaction with it comes to the fore. Studying the course of differential equations is traditionally associated with difficulties for students, because it often requires not only analytical abilities, but also spatial representation, modeling skills, and understanding of the applied essence of problems. In this context, the tools of computer mathematics play an important role: they make it possible to move from abstract reasoning to a visual computer experiment, thereby contributing to a deeper assimilation of the material.

Computational mathematics is a field that combines mathematical modeling, numerical methods, algorithmization, and software. In the educational process, it allows you to implement the following functions: interactive learning – visualization of complex mathematical processes; computer modeling – construction of mathematical models of real phenomena; automation of calculations – acceleration and optimization of problem solving; empirical testing of hypotheses – testing of theoretical results; student project activities – development of their own models and analysis.

Computer tools do not replace mathematical apparatus, but on the contrary, they expand its application.

Let us outline the main advantages of using the Python programming environment as a means of supporting the educational process when studying differential equations. Python is a programming language that is actively used today in both scientific research and education. Its main advantages: simple syntax, accessible even to beginners; powerful libraries for working with mathematics; NumPy – linear algebra, arrays; SciPy – numerical integration, ODE solving methods; SymPy – symbolic calculations, analytical solutions; Matplotlib – plotting

and visualization; Jupyter Notebook – an interactive environment for writing, executing, and documenting code.

With the help of these tools, you can implement most of the classic course tasks, supplementing students' theoretical knowledge with an applied component.

Let's give an example of visualizing the direction field and isocline of a differential equation using the Python programming environment. Let's consider the first-order differential equation $y' = y - x2 + 1$, and construct the direction field for it and the isocline $y' = 0 \rightarrow y = x2 - 1$.

Here is the code for constructing the direction field and isocline graph of this equation (Fig. 1).

```
import numpy as np
import matplotlib.pyplot as plt
# Сітка для поля напрямків
x = np.linspace(-2, 2, 20)
y = np.linspace(-1, 3, 20)
X, Y = np.meshgrid(x, y)
# Похідна
dy_dx = Y - X**2 + 1
U = np.ones_like(dy_dx)
V = dy_dx
N = np.sqrt(U**2 + V**2)
U2, V2 = U / N, V / N
# Побудова графіка
fig, ax = plt.subplots(figsize=(8, 6))
ax.quiver(X, Y, U2, V2, angles=«xy», color=«blue», width=0.005)
# Побудова ізокліни y' = 0 y = x2 - 1
x_iso = np.linspace(-2, 2, 500)
y_iso = x_iso**2 - 1
ax.plot(x_iso, y_iso, 'r-', linewidth=2.5, label=«Ізокліна y' = 0»)
# Оформлення графіка
ax.set_title(«Поле напрямків та ізокліна для y' = y - x² + 1»)
ax.set_xlabel(«x»)
ax.set_ylabel(«y»)
ax.grid(True)
ax.legend()
ax.set_xlim(-2, 2)
ax.set_ylim(-1, 3)
# Збереження зображення
image_path_fixed = pole_napryamkiv_izoklina_fixed.png»
plt.savefig(image_path_fixed)
plt.close()
```

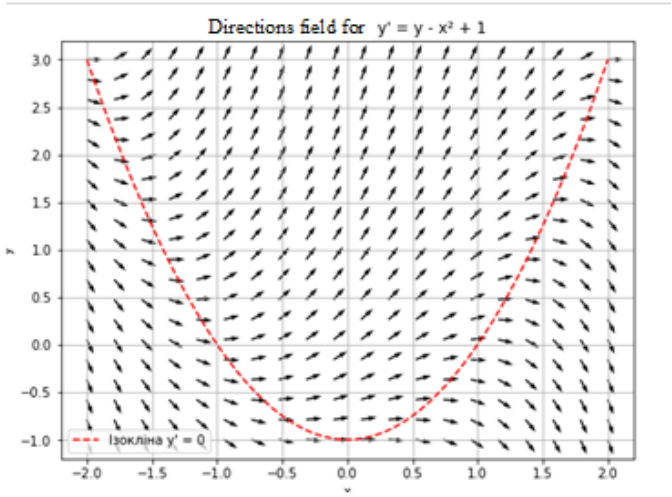

Fig. 1. Construction of the direction field and isocline graph of the differential equation

The study tested the integration of Python into the teaching of differential equations: a series of interactive practical exercises were developed; templates were created in Jupyter Notebook;microprojects for creating mathematical models were introduced.

The results indicate increased student interest and better assimilation of the material.

Integrating computer mathematics tools, including Python, into the differential equations course is an effective way to modernize mathematics education. This allows combining theoretical material with applied analysis, developing computer modeling skills, and increasing student motivation.

References

1. Pichkur V. V., Kapustyan O. V., Sobchuk V. V. Theory of dynamic systems : a textbook. Lutsk : VezhaDruk, 2020. 348 p.

2. Samoilenko A. M., Perestyuk M. O., Parasyuk I. O. Differential Equations. Kyiv : Lybid, 2003. 600 p.

3. Kiusalaas J. Numerical Methods in Engineering with Python. Cambridge University Press, 2010.

4. Oetiker T., Rankin S., Schlegel M. Matplotlib and Jupyter for Scientists, 2022.

ON THE ISSUE OF FOREIGN LANGUAGE COMMUNICATION AND COMPETENCE OF A VETERINARY STUDENT

Podoliak Mykhailo
PhD in Pedagogy, Assistant Professor of the Department of the Ukrainian and Foreign Languages
n. a. Iakym Iarema,
Stepan Gzhytskyi National University of Veterinary Medicine and Biotechnologies Lviv,
misha.podol@gmail.com

The study of the regulatory framework of higher veterinary education in Ukraine and educational and professional programs of specialty 211 «Veterinary Medicine» of domestic higher education institutions indicates the mandatory study of a foreign language course to prepare students – future veterinarians for foreign language communication. It, therefore, determines the need to clarify the content of