

PYTHON – A MODERN ENGINEERING TOOL

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Abstract. This work focuses on the world's trend towards automation and computerization, emphasizing the importance of acquiring programming skills. It explores why Python is the ideal language for engineers to delve into programming, and examines its applications in various engineering-related fields such as data analysis, fluid mechanics, and others.

Keywords: STEM occupations, python as a tool, NumPy, SciPy, Python approach, Python at university.

Introduction

The world is striving for digital innovation and automation, that way it is expected, that programming will be a valuable skill in the workplace. The report “STEM Occupations: Past, Present and Future” (2017) (STEM: Science, Technology, Engineering, Math) provided by U.S Bureau of labor statistics confirms, that there is a tendency for computer related occupations. The Fig. 1 shows that more than 30% of STEM employment in USA in 2015 were computer occupations. Or it can be seen at the Fig. 2, that most of projected new jobs from 2014 to 2024 will be again computer related. So, to get a prestigious job in the 21th century it is very important to know programming language, or at least to have some understanding in it. If a person has a chance to learn a programming language it is good time to start and the best one to enter the world of computers and automation is the Python [1].

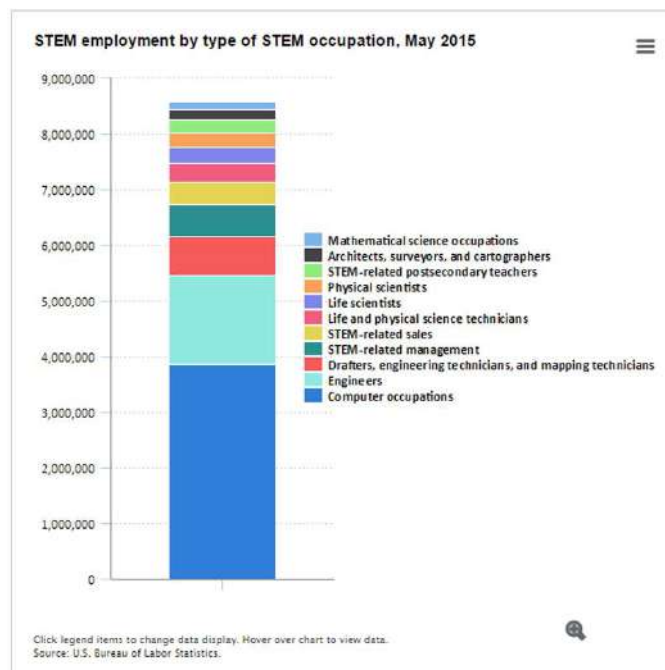


Figure 1. STEM employment by type of STEM occupation, May 2015, USA

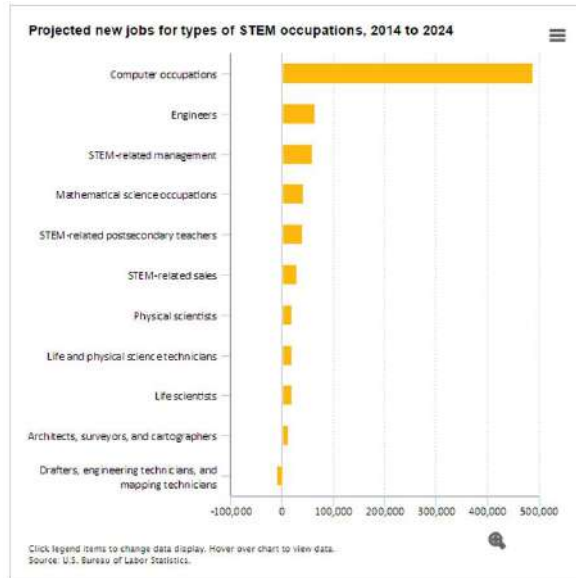


Figure 2. Projected new jobs of STEM occupations, 2014 to 2024, USA

What is Python

Python is a computer programming language often used to build websites and software, automate tasks, and conduct data analysis. Python is a general-purpose language, meaning it can be used to create a variety of different programs and isn't specialized for any specific problems. This versatility, along with its beginner-friendliness, has made it one of the most-used programming languages today [2].

Why Python is the best language to start?

After a comparison, it can be seen that for the same output, code, written in Python is much simpler and more readable for a human, so it takes several weeks to get some basic, not 2-3 month like in Java. It is one of the most significant advantages of the Python see Fig. 3, [3].

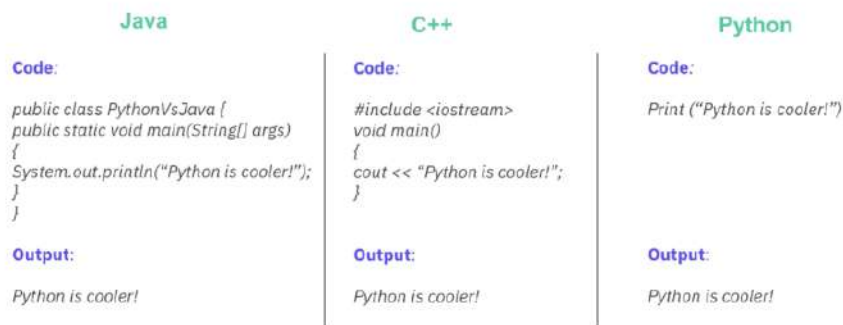


Figure 3. Code in different programming languages for similar output

Python is used everywhere, in areas like web development, data science, AI, scientific research and more. There are some big companies which are still using python like, Google. Peter Norwig, Engineering Director at Google has said that:

“Python has been an important part of Google since the beginning, and remains so as the system grows and evolves. Today dozens of Google engineers use Python, and we are looking for more people with skills in this language” [4].

Cuong Do, Software Architect, YouTube.com noticed:

“Python is fast enough for our site and allows us to produce maintainable features in record times, with a minimum of developers” [4].

Another advantage of the Python, it is very popular among developers. Survey, with about 88 thousand participants, made by STATISTA in 2023, shows that more than 49% of respondents used Python during their work. So, there are plenty of tutorials of Python available see Fig. 4, [3].

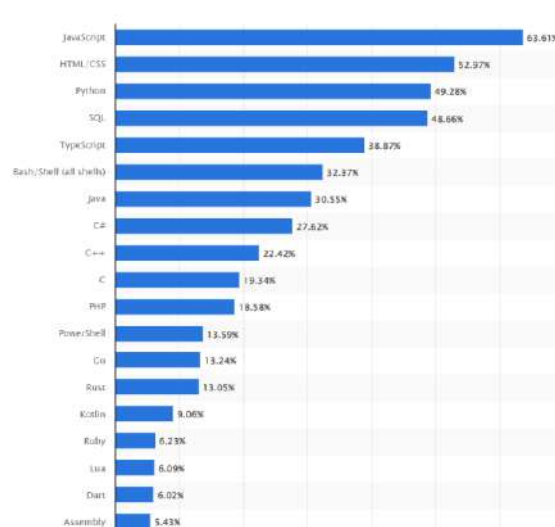


Figure 4. Most used programming languages among developers worldwide as of 2023

Python, as a tool for engineers

But there is a question appearing, “How can engineers use the Python?”, “Why should they be interested in learning this language?”. It is considered that mechanical, power and thermal power engineers work with real world things, like machines, cables, tubes, motors and generators, so they are usually avoiding programming. But the world is changing really fast, and there is a necessity to solve real problems as effective as possible, that is why programming is becoming a valuable skill for any kind of engineers to work smarter and faster instead of harder, and they often choose Python, as a tool, not other programming languages.

Python has a lot of library, like NumPy and SciPy, that can help to analyze huge amounts of data, for example, from thousands of sensors and machines at facility. That is very hard to do in Excel because the amount of data in facility is too big. Also, there are Python libraries, which help to visualize data: different kind of graphs. For instance, this is a scatter plot with multiple colors made using library Seaborn, in Python see Fig. 5, or another one, HeatMap again in Seaborn, with colors and values see Fig. 5 [6].

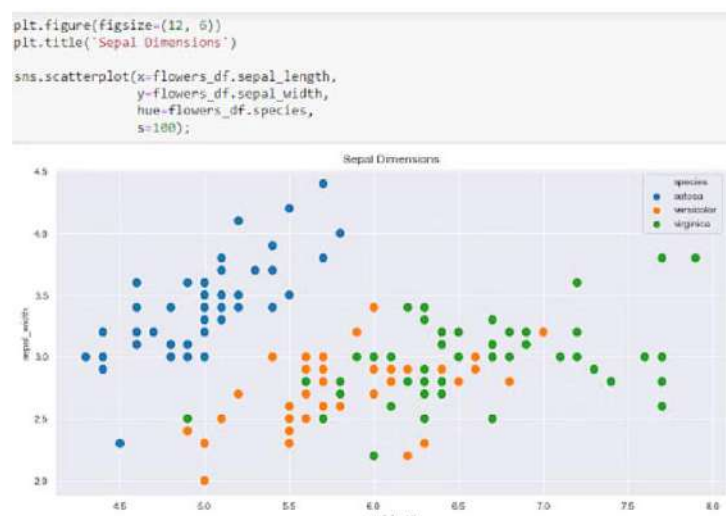


Figure 5. Scatter plot with multiple colors

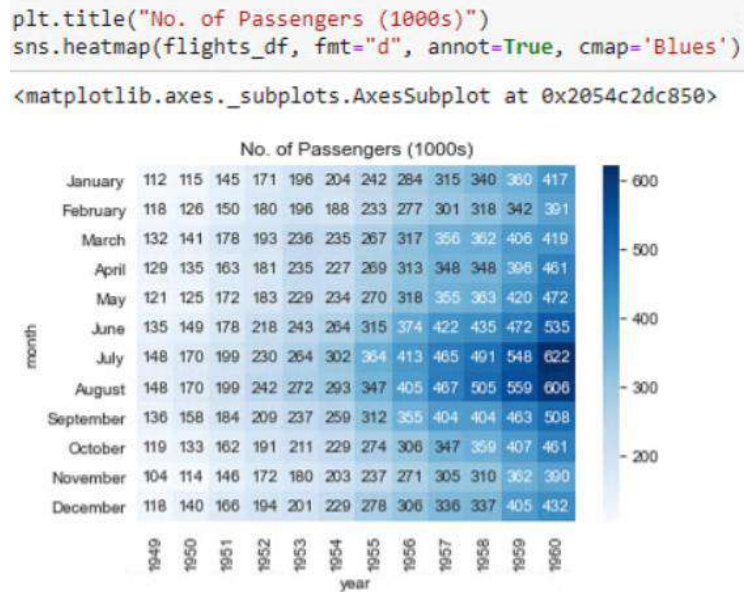


Figure 6. Plotting heat map with values

Python is very useful in computational fluid dynamics, for instance by using modules PyCFD, TESPpy and others mentioned before to solve First law thermodynamics equations, partial, differential equations or Navier-Stokes equations. For instance, this is an example of solving First Law Thermodynamics problem. By putting Cp, Pressures and temperature to the input, the quantity of heat and difference in internal energy can be obtained, see Fig. 7 [7], [8].

Example 5: The heat capacity at a constant pressure of a certain system is a function of temperature only and may be expressed as

$$C_p = 2.093 + \frac{41.87}{t + 100} J/^\circ C$$

where is the temperature of the system in C. The system is heated while it is maintained at a pressure of 1 atmosphere until its volume increases from 2000 to 2400 cm³ and its temperature increases from 0°C to 100°C [1].

- How much does the internal energy of the system increase?
- Find the magnitude of heat interaction.

Solution: The methodology will be to make functions of c_p and then supply the expressions to it. Then integrate() function is used to integrate it within limits to obtain Q. Then pressure and volumes are entered, and as Q is known, then ΔU can be evaluated easily by Eq. (5).

CODE	OUTPUT
<pre>from sympy import* from sympy.abc import* Cp = Function(T) Cp= input('enter the Cp as a function of T') Q=float(integrate(Cp, (T, 0, 100))) P= float(input('enter the pressure : ')) V1= float(input('enter the V1: ')) V2= float(input('enter the V2: ')) W= float(P*(V2-V1)) ΔU=Q-W print("Q = ", round(Q, 3)) print("ΔU = ", round(ΔU, 3))</pre>	<pre>enter the Cp as a function of T: 2.093+41.87/(T+100) enter the pressure : 101325 enter the V1: 0.002 enter the V2: 0.0024 Q = 238.322 ΔU = 197.792</pre>

Figure 7. Example of solving the First Law Thermodynamics problem, Python approach

For a person it is much easier to understand something if it is animated and visualized and the module FlowPy can do that, [9]:

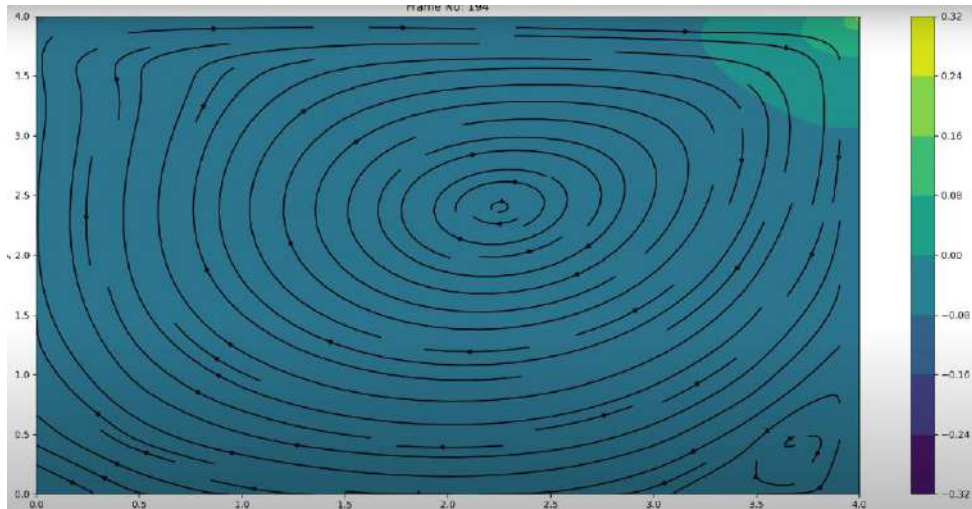
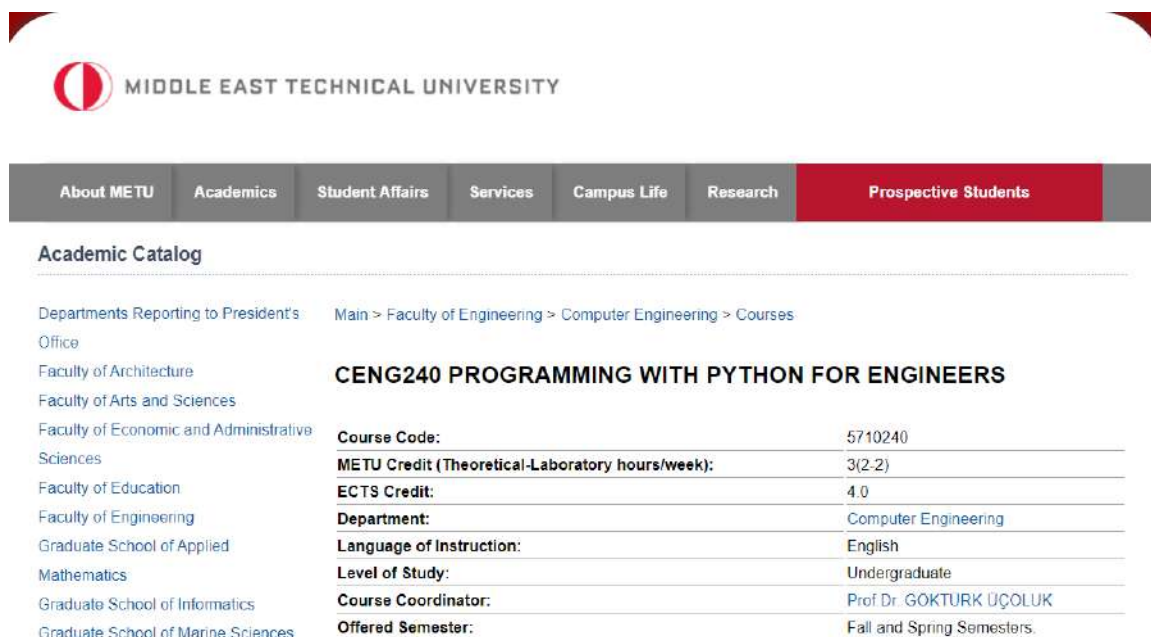


Figure 8. Lid cavity test benchmark using FlowPy

Python, as a university subject

Every year python becomes more popular. Some universities noticed that, that why they applied Python courses for all engineering programs. for instance, Middle East Technical University, the best technical university of Turkey has the course “Programming with Python for Engineers” and 1027 students in METU got it last semester, [10].



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CENG240 PROGRAMMING WITH PYTHON FOR ENGINEERS

Course Code:	5710240
METU Credit (Theoretical-Laboratory hours/week):	3(2-2)
ECTS Credit:	4.0
Department:	Computer Engineering
Language of Instruction:	English
Level of Study:	Undergraduate
Course Coordinator:	Prof Dr. GOKTURK UÇOLUK
Offered Semester:	Fall and Spring Semesters.

Figure 9. Programming with Python for Engineers course in Middle East Technical University

Conclusion

Digitalization is a trend of modern development of the world, that is why programming becomes important, not only for programmers, but for all kinds of jobs, especially, for engineering ones. To follow the world’s trend, engineering students should be offered some programming subjects, especially, Python. It is simple, modern, useful in calculations and students can enter the world of programming through comfortable and easy path.

References:

- [1] S. Fayer, A. Lacey & A. Watson, *STEM Occupations: Past, Present, And Future*. U.S Bureau of Labor Statistics, 2017. Available: <https://www.bls.gov/spotlight/2017/science-technology-engineering-and-mathematics-stem-occupations-past-present-and-future/pdf/science-technology-engineering-and-mathematics-stem-occupations-past-present-and-future.pdf>
- [2] “COURSERA.” [Online], *What Is Python Used For? A Beginner’s Guide*. Available: <https://www.coursera.org/articles/what-is-python-used-for-a-beginners-guide-to-using-python>
- [3] “Codeop.” [Online], *Reasons Why Python is the Easiest Coding Language to Learn First*. Available: <https://codeop.tech/5-reasons-why-python-is-the-easiest-coding-language-to-learn-first/#:~:text=It%20uses%20English-like%20words,language%20in%20a%20shorter%20time.>
- [4] “Python™” [Online], *Quotes about Python*. Available: [https://www.python.org/about/quotes/#:~: text="Python%20has%20been%20an%20important,search%20quality%20at%20Google%2C%20Inc.](https://www.python.org/about/quotes/#:~:text=%20has%20been%20an%20important,search%20quality%20at%20Google%2C%20Inc.)
- [5] “Statista.” [Online], *Most used programming languages among developers worldwide as of 2023*, Available: <https://www.statista.com/statistics/793628/worldwide-developer-survey-most-used-languages/>
- [6] “SIMPLiLEARN.” [Online], *A Complete Guide to Data Visualization in Python With Libraries & More*. Available: <https://www.simplilearn.com/tutorials/python-tutorial/data-visualization-in-python#what is data visualization>
- [7] “IoT for All.” [Online], *The Power of Python: A Must-Have Tool for Mechanical Engineers*. Available: <https://www.iotforall.com/the-power-of-python-a-must-have-tool-for-mechanical-engineers>
- [8] “ResearchGate.” [Online], *First Law of Thermodynamics for Closed System: A Python Approach*. Available: [https://www.researchgate.net/publication/364329343 First Law of Thermodynamics for Closed System A Python Approach](https://www.researchgate.net/publication/364329343_First_Law_of_Thermodynamics_for_Closed_System_A_Python_Approach)
- [9] Gaurav Deshmukh, *Lid Cavity Test Benchmark using FlowPy*. Available: https://www.youtube.com/watch?v=OZg_CP_UCJI&list=PPSV
- [10] “Middle East Technical University” [Online], *CENG240 PROGRAMMING WITH PYTHON FOR ENGINEERS*. Available: https://catalog.metu.edu.tr/course.php?course_code=5710240