

Module – 1 : Python - Fundamentals of Python Language

1) Introduction to Python and its Features.

- Python is interpreted object-oriented, high-level programming language with dynamic semantics.
- Python known for its simplicity and readability.
- Python supports modules and packages, which encourages program modularity and code reuse.
- Python allowing access to many external libraries.
- **Features :**
- **Easy to Learn and Use:** Python has a simple syntax similar to English, making it beginner-friendly.
- **Dynamically Typed:** You don't need to declare variable types explicitly.
- **Highly portable:** Runs almost anywhere - high end servers and workstations, cross platform.
- **Reduced development time:** Code is 2-10x shorter than C, C++, Java.

2) History and Evolution of python.

- Python was conceived in the late 1980s by Guido van Rossum at the Centrum Wiskunde & Informatica (CWI) in the Netherlands.
- Guido aimed to create a language that was easy to read and powerful enough for advanced programming.
- 1989 – ABC Language.
- 1991 – Python (0.9.0)
- 1994 – Python (1.0.0)
- 2000 – Python (2.0.0)
- 2008 – Python (3.0.0) but Python 2 is running parallel.
- 2020 – Python (3.0.0) and Python 2 is retired.
- **Evolution :**
- **Open Source:** Python has always been freely available and open source, encouraging community contributions.
- **Wide Adoption:** Used in web development, data science, automation, AI, and more.
- **Rich Ecosystem:** Thousands of libraries and frameworks have been developed for Python.

3) Advantages of using Python over other programming languages.

- **Simple and Readable Syntax:**
Python's syntax is clear and close to English, making code easy to write and understand.
- **Versatile and Multi-Paradigm:**
Supports procedural, object-oriented, and functional programming styles.
- **Extensive Standard Library:**
Comes with a rich set of modules for tasks like file I/O, networking, web development, and more.
- **Platform Independent:**
Python runs on Windows, macOS, Linux, and many other platforms without modification.
- **Large Community and Support:**
Huge global community, lots of tutorials, forums, and third-party packages.
- **Rapid Development:**
Ideal for prototyping and quick development due to concise code and dynamic typing.
- **Integration Capabilities:**
Easily integrates with other languages (C, C++, Java) and technologies (web, databases).
- **Strong Support for Data Science and AI:**
Popular libraries like NumPy, pandas, TensorFlow, and scikit-learn make Python the top choice for data analysis and machine learning.
- **Open Source:**
Free to use and distribute, with a permissive license.
- **Great for Automation:**
Widely used for scripting and automating repetitive tasks.

4) Installing Python and setting up the development environment.

(Anaconda, PyCharm, or VS Code).

- **Install Python:**
Download: Go to the official Python website and download the latest version for Windows.
Install: Run the installer and check the box "Add Python to PATH" before clicking "Install Now".
- **Install VS Code (Recommended Editor):**
Download: Go to Visual Studio Code and download the installer for Windows.

- **Install:** Run the installer and follow the setup instructions.
- **Install Python Extension in VS Code:**
 - Open VS Code.
 - Go to Extensions (Ctrl+Shift+X).
 - Search for "Python" and install the official extension by Microsoft.
- **Verify Installation:**
 - Open Command Prompt and type:**
 - python --version
 - You should see the installed Python version.
- **Create and Run a Python File in VS Code:**
 - Open VS Code and create a new .py file.
 - Write your Python code (e.g., print("Hello, Python!")).
 - Right-click in the editor and select Run Python File in Terminal.

5) Writing and executing your first Python program.

- ```
print("Hello World!") #output ----- Hello World!
```
- ```
A = 24
B = 6
print("A+B : ",A+B)    #output ----- 30
```

6) Understanding Python's PEP 8 guidelines.

- PEP 8 is the official style guide for Python code. It provides conventions for writing readable and consistent Python code.
- **Indentation:** Use 4 spaces per indentation level.
- **Maximum Line Length:** Limit lines to 79 characters.
- **Blank Lines:** Use blank lines to separate functions, classes, and blocks of code.
- **Imports:** Imports should be on separate lines and at the top of the file.
- **Spaces:**
 - No extra spaces inside parentheses, brackets, or braces.
 - Use a single space after commas, colons, and semicolons.
 - No spaces before a comma, semicolon, or colon.
- **Comments:** Use comments to explain code, but keep them concise and relevant.
- **String Quotes:** Use single or double quotes consistently.

7) Indentation, comments, and naming conventions in Python.

- **Indentation :**

Python uses indentation (spaces) to define code of block.
Use 4 space per indentation level.
No curly braces are used for blocks.

- **Comments :**

Single Line : #
Multi Line : """ _____ """

- **Naming Conventions:**

Variables and functions: lower_case_with_underscores
Classes: CapWords
Constants: ALL_CAPS_WITH_UNDERSCORES

8) Writing readable and maintainable code.

- **Use descriptive variable names:**

Instead of a and b, use names like greeting and target.

- **Add comments if necessary:**

Briefly explain the purpose of the code, especially if it's not obvious.

- **Consistent formatting:**

Follow consistent indentation and spacing.

9) Understanding data types: integers, floats, strings, lists, tuples, dictionaries, sets.

- **Integer :** Whole number

Ex: a = 10

- **Float :** Numbers with decimal

Ex: a = 10.25

- **String :** Sequence of characters

Ex: a = "Hello! Python is very easy language."

- **List :** Ordered, mutable collection

Ex: a = [1, 2, 5, 9, 6, 7]

- **Tuple :** Ordered, immutable collection

Ex: a = (1, 2, 5, 9, 6, 7)

- **Set :** Unordered collection of unique elements

Ex: a = {1, 2, 5, 9, 6, 7}

- **Dictionary** : Key-Value pair
Ex: `a = { "name": "Alice", "Age": 25}`

10) Python variables and memory allocation.

- Variables are names that reference objects in memory.
- When you assign a value to a variable, Python creates an object in memory and the variable points to it.
- Python uses dynamic typing, so you don't need to declare the type.
- If you assign one variable to another, both reference the same object (for mutable types, changes affect both).

11) Python operators: arithmetic, comparison, logical, bitwise.

- **Arithmetic Operators** : basic mathematical operation.

<code>+</code>	Addition	<code>5 + 3</code>	8
<code>-</code>	Subtraction	<code>5 - 3</code>	2
<code>*</code>	Multiplication	<code>5 * 3</code>	15
<code>/</code>	Division	<code>5 / 3</code>	1.67
<code>%</code>	Modulus	<code>5 % 3</code>	2
<code>**</code>	Exponentiation	<code>5 ** 3</code>	125
<code>//</code>	Floor division	<code>5 // 2</code>	2

- **Comparison Operators** : Used to compare values. Returns true and false.

<code>==</code>	Equal to	<code>5 == 5</code>	True
<code>!=</code>	Not equal to	<code>5 != 3</code>	True
<code>></code>	Greater than	<code>5 > 3</code>	True
<code><</code>	Less than	<code>5 < 3</code>	False
<code>>=</code>	Greater or equal	<code>5 >= 3</code>	True
<code><=</code>	Less or equal	<code>5 <= 3</code>	False

- **Logical Operators** : Used to combine conditional statements.

<code>and</code>	True if both true	True and False	False
<code>or</code>	True if one is true	True or False	True
<code>not</code>	Inverts the result	not True	False

- **Bitwise Operators** : Operate on bits (0s and 1s) of integers.

&	And	6 & 3	2
	Or	6 3	7
^	XOR	6 ^ 3	5
~	Not	~6	-7
<<	Left shift	6 << 3	48
>>	Right shift	6 >> 3	0

12) Introduction to conditional statements: if, else, elif.

- **If** : This statement checks a condition and condition is true, then block of code run.

Ex: **if a > b:**

```
print("a is greater than b.")
```

- **else** : When the if condition is false, then execute else block.

Ex: **if a > b:**

```
print("a is greater than b.")
```

else:

```
print("b is greater than a.")
```

- **elif** : Used to check multiple condition, only one block (the first True condition) will execute.

Ex: **if a > b and a > c:**

```
print("a is greater than b and c.")
```

elif b > a and b > c:

```
print("b is greater than a and c.")
```

else:

```
print("c is greater than a and b.")
```

13) Nested if-else conditions.

- A nested if-else means placing one if or else statement inside another. This is useful when decisions depend on more than one condition.

Ex: **mark = 84**

```
if mark >= 40:
    if mark >= 75:
        print("Distinction")
    else:
```

```
        print("Pass")
else:
    print("Fail!!")
```

14) Introduction to for and while loops.

- **For :** This loop is used to iterate over a sequence (like a list, string, range, etc.).

Ex : **for i in range(1,11):**
 print(i)

- **While :** This loop runs as long as a condition is True.

Ex : *i = 1*
 while n <= 10:
 print(i)
 i += 1

15) How loops work in Python.

- **For :** This loop automatically takes each item from a sequence (like a list, string, or range) and executes code for each item.

In above example, how it works?

range(1,11) gives [1, ----, 10]
Here 11(end) is not counted in loop.
Then, i takes [1, ----, 10]
And print on output window.

- **While :** This loop runs as long as a condition is True. It keeps checking the condition before every iteration, and stops when the condition becomes False.

In above example, how it works?

Start with i = 1
Check : i <= 10 ? Yes --> print 1
Increment value of i ----> i += 1
Check : i <= 10 ? Yes --> print 2
Repeats until i reaches 11
Then stop the loop.
And print on output[1, ----, 10] window.

16) Using loops with collections (lists, tuples, etc.).

- **Collections** : Lists, tuples, sets, and dictionaries store multiple items.
- **For loop** : Best for iterating directly over elements.

Ex : **for item in my_list:**
 print(item)

- **Index-based**: Use range(len(collection)) or enumerate() if you need the index.

Ex : **for i, val in enumerate(my_list):**
 print(i, val)

- **Tuples** : Iterated like lists but immutable.
- **Sets** : Iterated like lists but order is not guaranteed.

- **Dictionaries**:

 Keys --> for key in dict:
 Keys & values --> for k, v in dict.items():

- **While loop** : Used with index control.

Ex : **i = 0**
 while i < len(my_list):
 print(my_list[i])
 i += 1

17) Understanding how generators work in Python.

- **Definition**: Generators are special functions that yield values one at a time instead of returning them all at once.

- **Why use them**:

 Memory efficient (don't store all results in memory)
 Lazy evaluation (produce items only when needed)

- **How to create**:

 Use yield instead of return inside a function.

Ex : **def my_gen():**
 yield 1
 yield 2

- **How to use** :

Ex : **for value in my_gen():**
 print(value)

- **Normal function** :- Returns value once, ends.

- **Generator function** :- Pauses at yield, resumes from there on next call.

18) Difference between yield and return.

Aspect	return	yield
Function type	Normal function	Generator function
Execution	Ends function immediately	Pauses function and can resume
Values produced	Returns one final value	Can produce multiple values one at a time
Memory usage	Stores all results in memory	Generates values on demand (memory efficient)
State saving	Does not save state	Saves current state for next iteration
Usage	Used when you need all data at once	Used when you want to iterate over results lazily

19) Understanding iterators and creating custom iterators.

- An iterator is an object that can be iterated (looped) over.
- It implements two methods:
 - __iter__() → Returns the iterator object itself.
 - __next__() → Returns the next item from the collection.
- Raises StopIteration when there are no more items.
- **Built - In :**

Ex : my_list = [1, 2, 3]
 it = iter(my_list)
 print(next(it)) # 1
 print(next(it)) # 2
- **Custom :**

Define a class.
Implement __iter__() and __next__().

20) Defining and calling functions in Python.

- A function is a block of reusable code.
- Defined using the def keyword.

Ex : **def greet(name):**
 print("Hello," , name)

 greet("Vivek")

21) Function arguments (positional, keyword, default).

- **Positional :**
Passed in the same order as defined in the function.
Order matters.
- **Keyword :**
Specify argument name when calling.
Order doesn't matter.
- **Default :**
Function parameters can have default values.
If no value is given, the default is used.

22) Scope of variables in Python.

- Scope of a variable in Python defines where in the program the variable can be accessed.
- Python follows the LEGB Rule:

L = Local (inside a function)

E = Enclosing (in outer function for nested functions)

G = Global (declared at the top level of the program)

B = Built-in (Python's reserved keywords/functions)

1. Local Scope

- Variables declared inside a function.
- Accessible only within that function.
- Created when function starts, destroyed when it ends.

2. Enclosing Scope

- Variables in the outer (enclosing) function for nested functions.
- Accessible to inner functions if not overridden.

3. Global Scope

- Variables declared outside all functions.
- Accessible anywhere in the program unless shadowed by a local variable.

4. Built-in Scope

- Name reserved by python (ex : print, len, max).
- Always available but can be overridden.

23) Built-in methods for strings, lists, etc.

- These methods help in manipulating, accessing, and processing data without writing extra logic.
- **mystr** = “Hello! python is interpred, object oriented and high level programming language.”
- **String :**
upper() : Convert to uppercase
Ex : print(mystr.upper())

lower() : Convert to lowercase
Ex : print(mystr.lower())

count() : Count occurrences
Ex : print(mystr.count('o'))

strip() : Remove whitespace from start and end
Ex : print(mystr.strip())

replace(a, b) : Replace Substring
Ex : print(mystr.replace("python", "java"))

split() : Split into substring
Ex : print(mystr.split(","))

capitalize() : Capitalize the first letter of the string
Ex : print(mystr.capitalize())

title() : Capitalize the first letter of each word
Ex : print(mystr.title())

casifold() : Convert the string to lowercase for case-insensitive comparisons.
Ex : print(mystr.casifold())

startswith() : Check if the string starts with “Hello” and return boolean value.
Ex : print(mystr.startswith("Hello"))

endswith() : Check if the string ends with “!” and return boolean value.
Ex : print(mystr.endswith("!"))

find() : Find the first occurrence of “python” and return its index, or -1 if not found.

Ex : `print(mystr.find("python"))`

index() : Check if the string ends with “object” and return boolean value.

Ex : `print(mystr.index("object"))`

- **String Properties :**

mystr.isalpha() = It checks if all characters in the string are alphabetic.

mystr.isdigit() = It checks if all characters in the string are digits.

mystr.isalnum() = It checks if all characters in the string are alphanumeric (letters and numbers).

mystr.islower() = It checks if all characters in the string are lower.

mystr.isupper() = It checks if all characters in the string are upper.

24) Understanding the role of break, continue, and pass in Python loops.

- **Break** : Stops the loop completely.

Ex :

```
for i in range(10):
    if i == 4:
        break
    print(i)
```

- **Continue** : Skips the current iteration and goes to the next.

Ex :

```
for i in range(10):
    if i == 5:
        continue
    print(i)
```

- **Pass** : Does Nothing (Placeholder)

Ex :

```
for i in range(10):
    pass
```

25) Understanding how to access and manipulate strings.

- A string in Python is a sequence of characters enclosed in either:

Single quotes ''

Double quotes ""

Triple quotes """ "" or """ """ (for multi-line strings)

- Strings are indexed sequences.

- **Indexing :**
Starts from 0 for the first character.
Negative indexing (-1) starts from the last character.
- **Slicing :**
Slicing is used to extract a part of the string.
start :- index to begin (default 0)
end :- index to stop (excluded)
step :- interval between characters (default 1)
- Strings are immutable, once created, their content cannot be changed.
- String Operation : concatenation, repetition, string methods.....
- Strings are widely used for data storage, manipulation, and display.

26) Basic operations: concatenation, repetition, string methods (`upper()`, `lower()`, etc.).

- **Concatenation :** Join the two string.
Ex: `a = "Hello"`
 `b = "World"`
 `print(a + " " + b)`
- **Repetition :** Using the * operator with a string and an integer. It returns a new string repeated n times.
Ex : `print("Hi" * 3)`
- **upper() :** Converts to uppercase.
- **lower() :** Converts to lowercase.
- **strip() :** Removes spaces from both ends.
- **replace() :** Replace substring.
- **join() :** Joins list into string.
- **split() :** Splits into substring.
- **find() :** Finds index of substring.
- **count() :** Counts occurrences.

27) String slicing.

- String slicing in Python extracts a part of a string using the syntax.
- `string[start : end : step]`

- **mystr** = “Hello! python is interpred, object oriented and high level programming language.”

```
print(mystr[9])
print(mystr[4:12])
```

```
print(mystr[2:12:2])
print(mystr[:5])
```

28) How functional programming works in Python.

- **Definition** : A style where functions are first-class citizens (can be stored, passed, and returned).
- **Focus** : What to do, not how to do it.
- **Key Ideas** :
 - Pure functions** : No side effects, same input -- same output.
 - Immutability** : Avoid changing data directly.
 - Higher-order functions** : Functions that take/return other functions.
- **Common Tools** :
 - map(func, iterable)** : Apply function to all items.
 - filter(func, iterable)** : Keep items that match a condition.
 - reduce(func, iterable)** : Combine items into one value.
 - lambda** : Anonymous small function.

29) Using map(), reduce(), and filter() functions for processing data.

- **map()** :
 - Purpose** : Apply a function to each element of an iterable.
 - Syntax** : `map(function, iterable)`
 - Returns** : `map` object (convert to `list()` if needed).
- **filter()** :
 - Purpose** : Keep elements that match a condition.
 - Syntax** : `filter(function, iterable)`
 - Returns** : `filter` object (convert to `list()` if needed).
- **reduce()** :
 - Purpose** : Reduce sequence to a single value by repeatedly applying a function.
 - Syntax** : `reduce(function, iterable)`
 - Returns** : Single value.

30) Introduction to closures and decorators.

- **Closures** :
- **Definition** : A closure is a function inside another function that remembers variables from the outer function even after the outer function has finished executing.
- **Key Points** :
 - Inner function can access non-local variables.
 - Useful for data hiding and creating function factories.
- **Decorators** :
- **Definition** : A decorator is a function that takes another function as input, adds extra functionality, and returns a new function.
- **Often used for** :
 - Logging
 - Authentication
 - Measuring execution time
- **Syntax** :
 - Uses @decorator_name before a function.