Effective Teaching of "Introduction to Programming in Python"

(A Module in the CSEDU – Certificate Program in CS Education; csedu.iiitd.ac.in)

Objective

The aim of this module is to help teachers in colleges/universities (attendees) improve their teaching of the Introduction to Programming course in Python. After this module, the attendees will improve their teaching of this course, making use of:

- Clear demonstrations and discussions of effective teaching strategies
- Baseline materials (slides, assignments, online resources) that can be freely customized
- Opportunities to create further classroom and lab resources, and receive expert and peer feedback on these resources

The main learning outcomes of ***this module*** are:
At the end of the module, an attendee will:

- Have a clear understanding of the key student learning outcomes for the Introductory Programming course, and how the course design enables these learning outcomes
- Demonstrate an understanding of pedagogical strategies appropriate for this course
- Demonstrate fundamental skills in Python programming using modern tools for testing and debugging
- Create a portfolio of formative and summative assessments, and develop strategies for effective grading and providing constructive feedback

The focus of the module will be to help in delivering the Essential Learning Outcomes of the AICTE course syllabus. Some advanced topics may also be discussed, based on the inputs from the attendees.

Requirements for Module Attendees

The attendees for this module should:

- Have taught an Introductory Programming course earlier (need not be in Python)
- Have access to a good laptop (or desktop) and internet
- Commit to spending at least 5 hours per week (avg) for the module

Module Syllabus

The first two weeks will focus on understanding key student learning outcomes and the challenges they face in learning programming, based on a review of the relevant research and industry studies. Thereafter, we will follow a **problem-based** approach where we will discuss:

- Carefully chosen problems to introduce students to new syntax features
- Strategies for encouraging students to think of solutions
- Strategies for developing variant problems suitable for labs and exams

The week-wise syllabus for this module is:

Table

Wk	Module	Approach	Self-work for the week
1	• Discuss this module's goals for learners (teachers), approach • Discuss student learning outcomes	Guided discussion based on model curricula (AICTE, ACM/IEEE) and industry reports	Install necessary software, gain familiarity with LMS, review reading for Week 2
2	• Discuss challenges to attaining student learning outcomes • Discuss the feedback received from the attendees	Guided discussion based on selected research studies	Self-assessment of fundamental programming competence
3	**Problem**: Calculate $\sqrt{n}$ using a simple geometric method **Topics**: Variables and Expressions	Live programming using PythonTutor	Develop supporting lab materials, solve variant problems
4	**Problem**: Calculate the average of a number sequence terminated by a special value **Topics**: Assignment statements, loops	Introduction to test cases and debugging	Write code, debug code, and provide constructive feedback
5	**Problem**: Determine whether a password meets several "strength" conditions **Topics**: Conditionals, functions	Iterative code development	Solve and develop variant problems
6	**Problem**: Find the first occurrence of each unique letter in a string **Topics**: Python's list and built-in operations	Discussing multiple solutions	Solve a non-trivial problem (detailed problem specification, ~50 lines of code)
7	**Problem**: Fibonacci numbers with/without recursion, minimum of list **Topics**: Recursion	Motivating recursion and comparing recursion vs. iteration	Develop/complete a recursion vs. iteration lab
8	**Problem**: Find the k most frequent words in a string **Topics**: Dictionaries and advanced built-in operations	Runtime issues	Develop/complete a lab focused on efficiency and execution times

9	**Problem**: Access weather information using a web service API **Topics**: Advanced Python libraries, discussion of basic software engineering principles	Reading and using library documentation	Write basic code to access a web-service of self-interest via its API
10	Introductory Data Analytics and Machine Learning in Python	Key concepts and basic usage of built-in libraries	Debug code
11	Revision/Advanced topics – based on feedback		
12	Revision/Advanced topics – based on feedback		Proctored assessment of fundamental programming competence
13,14	Review of participant portfolios	Participant presentations, peer and expert feedback	

Schedule

The module will meet online once a week. In addition, a weekly help session to clear doubts and to help with the assignment will be provided through TA s. Details about joining these sessions will be provided later.
- **Weekly Session**: Thursday, 4:30 pm to 6 pm
- **Weekly help Session**: Saturday, 4:30 pm to 6 pm

Text to be used for the Module

We will not follow a specific textbook, but here are some recommended books/resources:
1. A Byte of Python, Swaroop Chitlur Haridas. https://python.swaroopch.com
2. Think Python: How to think like a Computer Scientist. Allen B. Downey. https://greenteapress.com/thinkpython2/html/index.html
3. Introduction to Computation and Programming Using Python, Second Edition With Application to Understanding Data, By John V. Guttag https://mitpress.mit.edu/books/introduction-computation-and-programming-using-python-second-edition (India Edition is available)
4. PythonTutor. https://pythontutor.com
5. The Joy of Computing using Python, NPTEL. https://nptel.ac.in/courses/106/106/106106182
6. Python 3 documentation. https://docs.python.org/3

Resources to be provided to attendees.

- Lecture Notes / ppt for the different topics in the course
- Some sample assignments for each of the major modules
- Some online resources which the attendees can use to revise/update their knowledge

Post Module Support

- A mailing list will be created and for a year, once every few months an online session of all attendees will be planned to share experiences and discuss challenges being faced