# Python Programming: Internals 2

AE04, 24th March, MSE

## Total Marks: 20

## 1 Qualitative understanding (5 marks)

Explain the structure of an object in object-oriented programming (OOPS) and the philosophy of OOP.

## 2 Quick answers (5 marks)

1. Which of the following correctly converts the string ‘”Welcome”‘ to uppercase in Python?

   (a) `’Welcome’.upper()`

   (b) `’Welcome’.toUpper()`

   (c) `’Welcome’.toUpperCase()`

2. Fill in the blank to correctly print the value of $i$ as long as it is less than 6.

```
i = 1
_____ i < 6: #Fill in the blank
    print(i)
    i += 1
```

3. What will be the result of the following syntax:

```
mylist = ['apple', 'banana', 'cherry']
print(mylist[-1])
```

4. Consider the following code:

```
a = 'Hello'
b = 'World'
print(a + b)
```

   What will be the printed result?

5. Use the add method to add ”orange” to the fruits set.

```
fruits = {"apple", "banana", "cherry"}
____________ #Fill in the blanks
```

## 3 Debugging (4 Marks)

The following Python class attempts to model the capital accumulation process in the Solow growth model. However, it contains two errors: one syntax error and one conceptual error.

```python
class SolowModel:
    def __init__(s, delta, alpha, A, k0):
        self.s = s
        self.delta = delta
        self.alpha = alpha
        self.A = A
        self.k = k0

    def next_period(self):
        investment = self.s * self.A * self.k ** self.alpha
        depreciation = self.delta * self.k
        k_new = investment - depreciation
        self.k = k_new

model = SolowModel(0.3, 0.1, 0.5, 2, 1)
print("Capital before:", model.k)
model.next_period()
print("Capital after:", model.k)
```

**Tasks:**

1. Mark the lines of code with errors above, then write the correct code in the space to the right.
2. Write the outputs of the corrected code in the space below.

## 4 Guess what the code does (3 Marks)

```python
def more(a,b, t):
    if t == 0:
        return a
    return more(a * (1 + b), b, t - 1)
```

**Tasks:**

1. (1 mark) If you run `print(more(100, 1, 3))`, what is the output on the screen?
2. (2 marks) What happens if you call `compound(100, 0.05, -1)`? Why?

## 5 Fill in the blanks (3 Marks)

Using a Monte Carlo simulation, a researcher wants to approximate $\sqrt{2}$. The idea is to randomly sample points $(x, y)$ in the square $[0, 2] \times [0, 2]$ and estimate the area under the curve $y = \sqrt{x}$. The true integral is:

$$\int_0^2 \sqrt{x}\, dx = \frac{2}{3}(2)^{3/2} = \frac{4}{3}\sqrt{2}.$$

Since the area of the sampling region is 4, the fraction of points under the curve estimates:

$$\frac{\text{Points under curve}}{\text{Total points}} \times 4 \approx \frac{4}{3}\sqrt{2}.$$

The following Python code attempts this simulation with 10,000 random points, but two lines of code are missing.

```python
import numpy as np
N = 10000
count = 0

for k in range(N):
    x, y = np.random.uniform(0, 2), np.random.uniform(0, 2)
    if y <=__________:  # (Fill in the missing condition)
       count+=1
area_estimate = (count / N) * 4
sqrt2_estimate = _______
print(sqrt2_estimate)
```

**Tasks:** Fill in the missing lines of code so the simulation correctly outputs an estimate of $\sqrt{2}$.