UNIVERSITY OF ESSEX

Undergraduate Examinations 2024

LARGE SCALE SOFTWARE SYSTEMS AND EXTREME PROGRAMMING

Time allowed: **TWO** hours (exam time) + **ONE** hour to allow for submission time (total **THREE** hours) (Please see your exam timetable or check on Canvas for the deadline to upload your answers)

Candidates are permitted to use:
Calculator – Casio FX-83GT Plus/X or Casio FX-85 GT Plus/X ONLY

Candidates must answer **ALL** questions

The paper consists of **FOUR** questions

The questions are **not** of equal weight

The percentages shown in brackets provide an indication of the proportion of the total marks for the **PAPER** which will be allocated.

Please note that the time allocated for this assessment includes time for you to download this question paper and answer paper and to upload your answers to Canvas.

Please allow at least 30 minutes at the end of your exam time to upload your work. Once you have completed the assessment do not leave it to the last minute to upload.

Please save your work throughout the examination to avoid losing your work.

Please do not communicate with any other candidate in any way during this assessment. Your response must be your own work. Procedures are in place to detect plagiarism and collusion.

Question 1

One of the key element in the extreme programming (XP) is Refactoring

a) Explain what is refactoring? [10%]

b) Explain why is refactoring important for XP? [10%]

c) Refactor this code below [5%]

```
#BMI: Body Mass Index ; W in kg ; H in meter
#Using the BMI formula BMI=W/H^2

while True:
  weight = float(input("Enter the Weight value: "))
  if weight > 0:
    break
while True:
  height = float(input("Enter the Height: "))
  if height > 0:
    break
print("The BMI is", weight / (height*height))
```

Question 2

a) Extreme programming insists on the software being in a deployable state at all times (that is: at the end of every iteration the software can be demoed to the clients). What makes this possible? [10%]

b) What role do customers/clients play in extreme programming? [10%]

Question 3

You are part of an extreme programming team that has been asked to build some mobile app/software that will be used for bike rental.

The company (Bikes2Go) places bicycles at many places around Singapore. The users/customers use mobile apps to discover the bike location and unlock and rent the bikes and will be charged hourly.

After finish renting the bike, users must park the bikes at some designated places, if not there will be penalty/fine applied.

You are asked to sketch a release plan for the software. Given the specific nature of the project you can act both as a programmer and as a client.

In your release plan please specify:

a) A list of the features and stories identified for the release [20%]

b) The value of each story for the customers using a point system where 3 = very valuable, 2 = valuable, 1 = optional. [5%]

c) An estimate of the programming effort required by each story based on the following scale: [5%]
E = Easy (takes 0 to 2 working days to the team)
M = Medium (takes 3 to 5 working days to the team)
D = Difficult (2 weeks)
X = eXtremely difficult (3 or more weeks)

Question 4

You have been asked to continue to develop a simple **Calculator** class, taking over from another programmer. Overleaf you will find two implementations of the class, one in Java and one in Python, together with unit tests for them.

The **Calculator** class can currently do two operations – addition and multiplication – on any two integer numbers. The result of such operations is stored in an accumulator register, **R1**, which is initially 0 (when an instance of calculator is created), overwriting any value previously stored in **R1**.

Users of the class call the method **evaluate** with a string argument representing the operation they want to execute. For instance, **evaluate("10 + 5")** will result in the value 15 being stored in **R1**, while **evaluate("5 * 5")** will result in 25 being stored in **R1**. Users can then retrieve the last result of an operation by calling the method **get_R1**.

a) While the production code (the class **Calculator**) written by the programmer so far is reasonably good, *it violates some principles of clean code*, which is essential for Extreme Programming. Choose one implementation of **Calculator**, study it, and indicate which refactorings would be needed to make the code cleaner (use line numbers to indicate which elements of the code should be affected).
Please, ignore the test class for this answer. [10%]

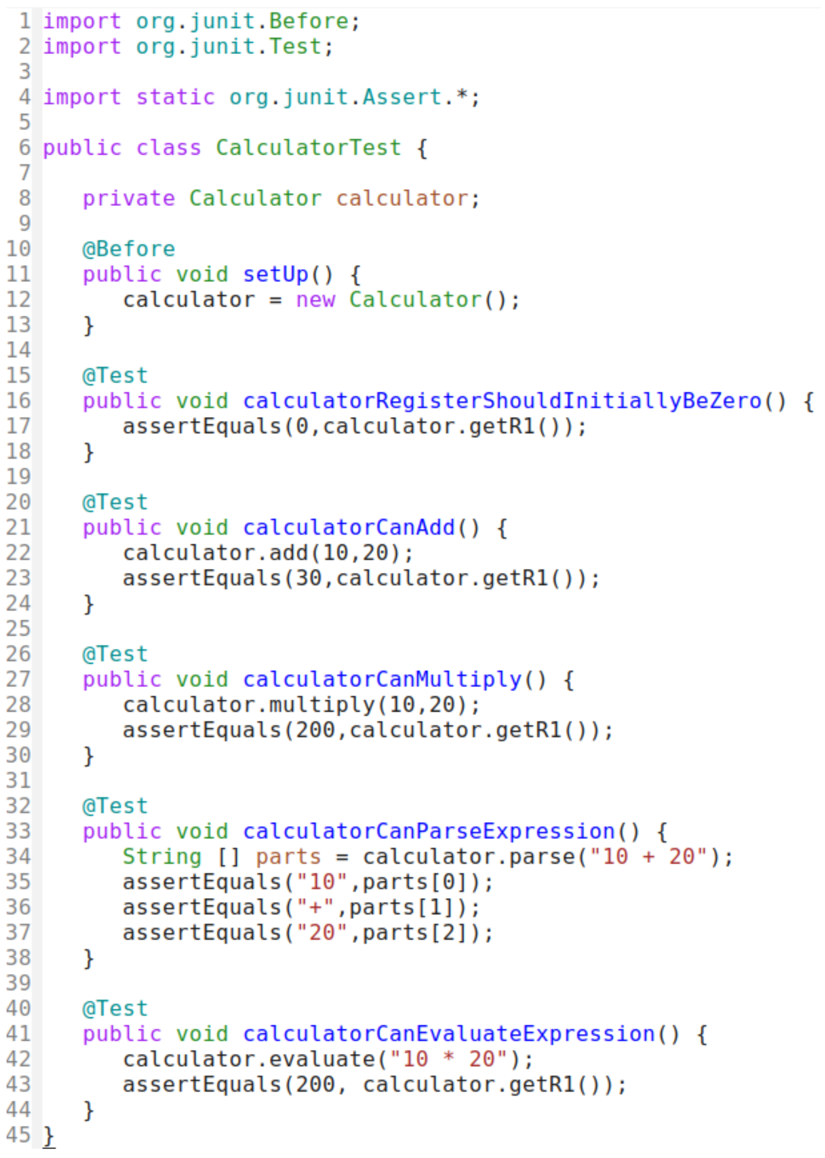
b) Write one or two tests which will force you to extend **Calculator** to add the following functionality: (1) the calculator will have a second register, **R2**, and (2) it will accept a new assignment instruction of the form **Register = Value**, which can set the value of either **R1** or**R2**. Thus, for example, **evaluate("R1 = 10")** will result in the value 10 being stored in **R1**,while **evaluate("R2 = 5")** will result in 5 being stored in **R2**. [8%]

c) Suggest which changes to the code would be required for the implementation of **Calculator** to acquire the functionality and pass the test(s) mentioned above (use line numbers to indicate the elements of the code that would be affected). [7%]

Calculator.java

```java
public class Calculator {
   private int R1 = 0;
   private final char[] OPERATORS = {'+','*'};

   int getR1() {
      return R1;
   }

   void add(int a, int b) {
      R1 = a + b;
   }

   void multiply(int a, int b) {
      R1 = a * b;
   }

   public void evaluate(String expression) {
      String[] elements = parse(expression);
      int a = Integer.parseInt(elements[0]);
      int b = Integer.parseInt(elements[2]);
      if (elements[1].equals("+"))
         add(a, b);
      else
         multiply(a, b);
   }

   String[] parse(String expression) {
      int position = findOperator(expression);
      return new String[]{
              // This is the first operand
              // (trim removes leading and trailing spaces)
              expression.substring(0,position).trim(),
              // This is the operator (e.g., *, /, -, ...)
              expression.substring(position,position+1),
              // This is the second operand
              expression.substring(position+1).trim()};
   }

   private int findOperator(String expression) {
      for(char operator: OPERATORS) {
         int operatorPosition = expression.indexOf(operator);
         if ( operatorPosition != -1)
            return operatorPosition;
      }
      return -1;
   }
}
```

CalculatorTest.java

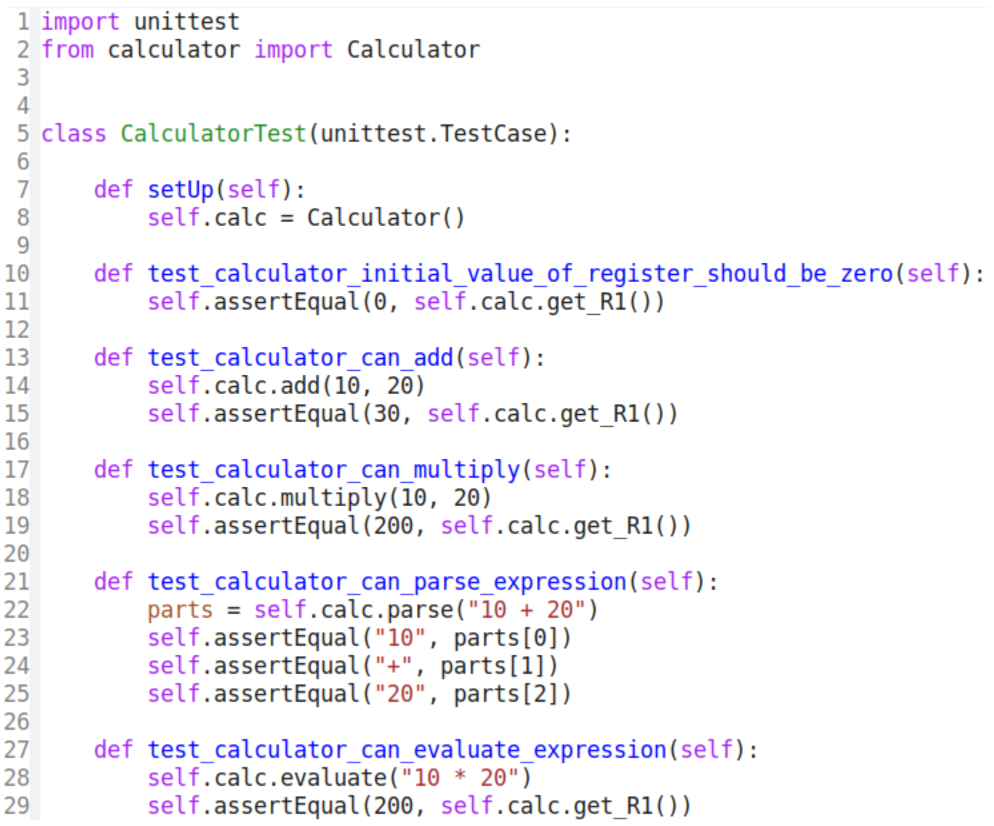


```java
import org.junit.Before;
import org.junit.Test;

import static org.junit.Assert.*;

public class CalculatorTest {

   private Calculator calculator;

   @Before
   public void setUp() {
      calculator = new Calculator();
   }

   @Test
   public void calculatorRegisterShouldInitiallyBeZero() {
      assertEquals(0,calculator.getR1());
   }

   @Test
   public void calculatorCanAdd() {
      calculator.add(10,20);
      assertEquals(30,calculator.getR1());
   }

   @Test
   public void calculatorCanMultiply() {
      calculator.multiply(10,20);
      assertEquals(200,calculator.getR1());
   }

   @Test
   public void calculatorCanParseExpression() {
      String [] parts = calculator.parse("10 + 20");
      assertEquals("10",parts[0]);
      assertEquals("+",parts[1]);
      assertEquals("20",parts[2]);
   }

   @Test
   public void calculatorCanEvaluateExpression() {
      calculator.evaluate("10 * 20");
      assertEquals(200, calculator.getR1());
   }
}
```

Calculator.py

```
class Calculator:
    OPERATORS = ['+', '*']

    def __init__(self):
        self.R1 = 0

    def get_R1(self):
        return self.R1

    def add(self, a, b):
        self.R1 = a + b

    def multiply(self, a, b):
        self.R1 = a * b

    def evaluate(self, expression):
        elements = self.parse(expression)
        a = int(elements[0])
        b = int(elements[2])
        if elements[1] == "+":
            self.add(a, b)
        else:
            self.multiply(a, b)

    def parse(self, expression):
        position = self.find_operator(expression)
        return [
            # This is the first operand
            # (strip removes leading and trailing spaces)
            expression[:position].strip(),
            # This is the operator (e.g., *, /, -, ...)
            expression[position],
            # This is the second operand
            expression[position + 1:].strip()]

    def find_operator(self, expression):
        for operator in self.OPERATORS:
            operator_position = expression.find(operator)
            if operator_position != -1:
                return operator_position
        return -1
```

Calculator_test.py



```python
import unittest
from calculator import Calculator


class CalculatorTest(unittest.TestCase):

    def setUp(self):
        self.calc = Calculator()

    def test_calculator_initial_value_of_register_should_be_zero(self):
        self.assertEqual(0, self.calc.get_R1())

    def test_calculator_can_add(self):
        self.calc.add(10, 20)
        self.assertEqual(30, self.calc.get_R1())

    def test_calculator_can_multiply(self):
        self.calc.multiply(10, 20)
        self.assertEqual(200, self.calc.get_R1())

    def test_calculator_can_parse_expression(self):
        parts = self.calc.parse("10 + 20")
        self.assertEqual("10", parts[0])
        self.assertEqual("+", parts[1])
        self.assertEqual("20", parts[2])

    def test_calculator_can_evaluate_expression(self):
        self.calc.evaluate("10 * 20")
        self.assertEqual(200, self.calc.get_R1())
```

END OF EXAM PAPER

Once you have completed your answers, please upload them to Canvas
https://lms.kaplan.com.sg/

Remember to add your REGISTRATION NUMBER onto ALL documents that you upload.