Computing Intermediate Test – February 2015

Choose ANY 8 questions

1)

    a. What is the difference between System Flowchart and Program Flowchart? (2)

    Solution: A system flowchart shows how data flows in an information system. A program flowchart is a detailed description of the logic of a program.

    b. What is the difference between a Class and an Object? (4)

    Solution: A class serves as a template from which one can create objects. The 'object' therefore is an instance of a class. A class (and therefore an object) consists of attributes (variables) and methods. For example if 'car' is a class, then objects of this class can be Ferrari, McLaren and Porsche.

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2) Use a flowchart OR write pseudocode that expresses the following program that decides whether a given year is a leap year or not:

    a. Start off using the year you want to calculate.

    b. See if it is divisible by 4. If it is not then it is not a leap year; if it is then continue with the next step.

    c. If the year is divisible by 4 but not by 100 it is a leap year. If it is divisible by both 4 and 100 then continue with the next step.

    d. If the year is divisible by 100 but not by 400 then it is NOT a leap year. If a year is divisible by both, then it is a leap year. (6)

Solution Pseudocode:

begin

    enter year;
    if year is not divisible by 4
        then return "not a leap year"
        else   if year is not divisible by 100
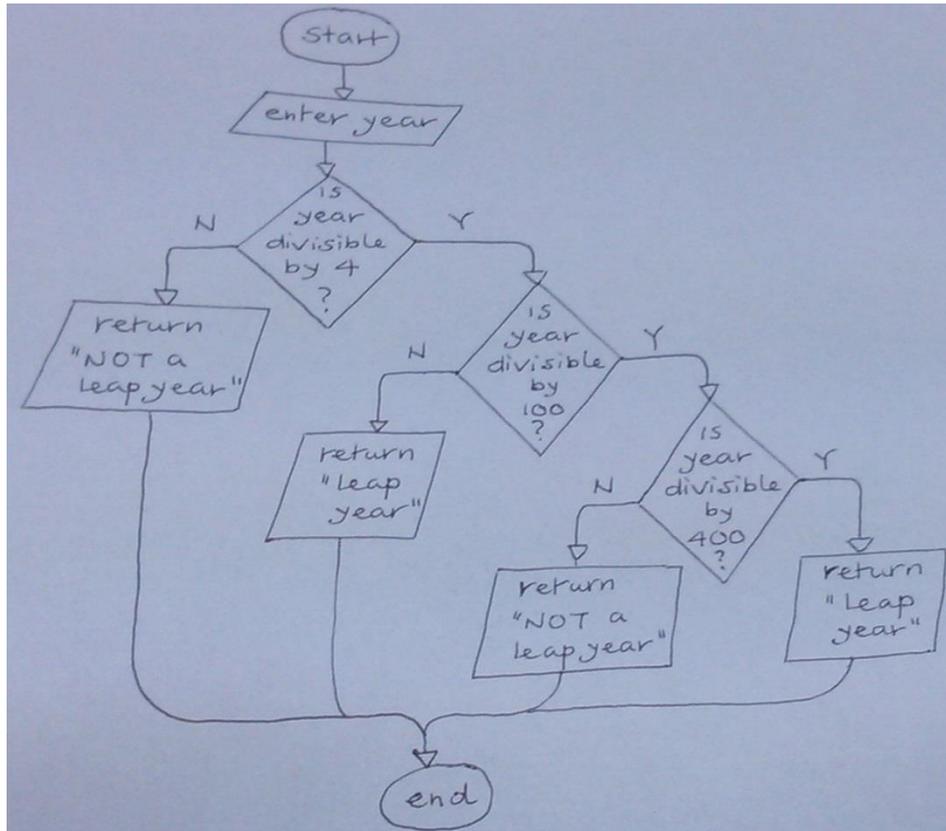   then return "leap year"
                else   if year is not divisible by 400
                        then return "not a leap year"
                        else return "leap year"
end

Solution Flowchart:

3)

    a. What do we mean by Selection Structure? (2)

Solution: Selection structure is also known as selective or conditional structure. In these structures a condition indicates to the program which statements to execute. There are two selection structures. These are: (a) if-then-else statement, and (b) switch (or 'case') statement.

Note: compare these with Linear structure, Repetition structure and Branch structure.

    b. What is the difference between the Imperative (procedural) paradigm and the Declarative paradigm? (4)

Solution: An imperative paradigm is a kind of programming where the programmer tells step by step to the computer the steps to be followed so that a problem is solved. These steps are found in a program. In a declarative paradigm the programmer simply describes what they need and now how it is to be done. Therefore the programmer writes down WHAT is needed and not HOW this will be achieved.

4)

    a. Name the three kinds of loops found in Java. (3)

Solution: For loop, while loop, do … while loop.

b. What is the difference between them? (3)

Solution: The 'for loop' is usually used when the number of iterations is known beforehand. The 'while loop' is pre-tested since the condition that determines whether the iteration is to be repeated or not is found at the start of the loop. The 'do … while loop' is post tested since the condition is found at the end of the loop structure. For this reason the 'do … while loop' is always performed at least once while the other two loops are not guaranteed this.

5) Explain the following branch statements: break statement, continue statement, goto statement and return statement. (6)

Solution: The 'break' statement, when used in a loop, stops the loop and the program continues its execution from the line immediately after the loop. When used in the switch statement it causes the termination of the statement.

The continue statement causes the termination of the present iteration but not the exit from the loop.

Goto causes a jump. The program will continue execution from the label indicated in the goto statement.

The return statement is used so that a method can pass on a value when it finishes its execution.

6)

a. What is the difference between Static and Dynamic data structures?(2)

Solution: A static data structure is such that during its declaration (definition) its size is established and cannot be changed during the execution of the program. On the other hand a dynamic data structure can grow to any size during the execution of the program. For example an array is a static data structure. An array list is dynamic.

b. In the Object-Oriented paradigm what do the following terms mean: Encapsulation, Inheritance and Polymorphism? (3)

Solution: Encapsulation is the property that allows a class to keep together attributes and methods and consider the whole group as one class or object. Inheritance permits a class to be derived from another class (called superclass). The derived class (called subclass) inherits all the attributes and methods of the superclass. Polymorphism allows a feature to change during the execution of a program e.g. a method that calculates the area of a shape will change according to whether it is calculating the area of a circle or a square.

c. What is a Static method? (1)

Solution: A static method is one that can be called from another class without the need to create an object of that class. A non-static method is called an instance method.

7) Explain how the data structures Stack and Queue work. Name one application for each. (6)

Solution: A stack is a data structure that simulates a stack of items put one above another in such a way that when a new item is included in the stack it is put on top and when an item is removed it is the one at the top that is removed. This is called a LIFO (Last In First Out) discipline. When an item is put on top of the stack the operation is called 'push'. When the top item is removed the operation is called 'pop'. One application of stacks is for a program, during execution, to keep track of where it must return after finishing methods.

A queue is a data structure that follows a FIFO (First In First Out) discipline. It follows the principles of a normal queue where elements arriving at the queue are placed at the end of the queue and the element that leaves the queue is the first element. The Queue has two basic operations which are 'insert' (also called 'enqueue') and 'remove' (also called 'dequeue'). One application of the queue is to keep track of files to be printed (spooler).

8)

    a. What do we mean by the Scope of a variable? (2)

    Solution: A variable's 'scope' refers to those parts of the program in which the variable can be used. For example if a variable is declared inside a method it cannot be used outside that method. We say that the scope of the variable is the method. We also say that the variable is visible within the method but is not visible outside the method.

    b. When we refer to Java what do we mean by Primitive types and Reference types? (4)

    Solution: Primitive types (also called atomic) are types involving only one value like integer or Boolean. Java has eight primitive types. Strings are not primitive types because they can be split into a number of characters. The other types consist of data structures that hold various values. A variable of a primitive type will hold its value but a variable representing a data structure will hold the reference (address) of the structure's starting location in RAM.

9)

    a. Evaluate the following expressions:

       i. 7 + 42 mod 5 (1)

       Solution: 7 + 2 = 9

      ii. True OR false AND false (1)

> **Solution**: True OR false = true

b. Explain what we mean by Precedence of Operators and Associativity of Operators. (4)

Solution: By precedence of operators we mean the order in which operators have to be applied for example multiplication is executed before addition, AND is executed before OR and after NOT etc. Associativity of operators tells us what happens when we have the same operator more than once in an expression for example if more than one multiplication sign is found, the leftmost one is calculated first.

10)

a. Give the algorithm of the Linear Search. (2)

Solution:
Given an array A
Indices of A start with 0 and end at N-1
To find the value k

```
begin
        found = false;
        index = 0;
        while (found = false) and (index <= N-1) do
                begin
                        if A[index] = k
                                then found = true
                                else increment index by 1
                end
        if found = true
                then return index
                else return -1
end
```

b. Show how the sorting of the following numbers is performed EITHER by the Insertion OR the Bubble sort: 25, 78, 3, 40, 61, 58. State which sorting algorithm you are using. (3)

Solution Insertion sort:

The first element is sorted 25, 78, 3, 40, 61, 58
Sort the second element 25, 78, 3, 40, 61, 58
Sort the third element 3, 25, 78, 40, 61, 58
Sort the fourth element 3, 25, 40, 78, 61, 58
Sort the fifth element 3, 25, 40, 61, 78, 58
Sort the last element 3, 25, 40, 58, 61, 78

Solution for Bubble sort:

Swap: 25, <u>78</u>, <u>3</u>, 40, 61, 58
Swap: 25, 3, <u>78</u>, <u>40</u>, 61, 58
Swap: 25, 3, 40, <u>78</u>, <u>61</u>, 58

Swap: 25, 3, 40, 61, <u>78</u>, <u>58</u>
25, 3, 40, 61, 58, 78
Start second pass
Swap: <u>25</u>, <u>3</u>, 40, 61, 58, 78
Swap: 3, 25, 40, <u>61</u>, <u>58</u>, 78
3, 25, 40, 58, 61, 78
Start third pass
No swaps, therefore the numbers are sorted.

c. With reference to Java what is an API? (1)

Solution: API, an abbreviation of Application Program Interface, is a set of constants, variables, methods and other tools for building software applications. The API can be imported in a program and the program can make use of all the defined items in the API.

11)

a. Explain what is meant by the following terms: formal language, syntax, semantics, context-free grammar. (4)

Solution: A formal language is a computer language. Syntax means the rules of how a program should be written i.e. the grammar. Semantics refers to the meaning of what is written. A context-free grammar is one where each element of the grammar has one and only one meaning and so it is free of any ambiguity.

b. What is the difference between Static and Instance variables? (2)

Solution: A static variable has the same value for all the objects derived from the same class. An instance variable does not necessarily have the same value in each object.