JURONG PIONEER JUNIOR COLLEGE

JC2 Year – End Examination 2020

COMPUTING   **9569/01**
Higher 2   **16 September 2020**

Paper 1 (Written)   **3 hours**

Additional materials: Answer Paper
                             Cover Page

READ THESE INSTRUCTIONS FIRST

Answer papers will be provided with the question paper.

Write your name and civics class on all the work you hand in.

Write in dark blue or black pen on both sides of the paper.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Answer **all** the questions.

Approved calculators are allowed.

You are reminded of the need for clear presentation in your answers.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets **[ ]** at the end of each question or part question.

The total number of marks for this paper is **100**.

This document consists of **9** printed pages and **1** blank page.

1   A one-dimensional array `X` will be used to record the timings of the participating teams racing in a 200 metres dragon boat race event. Five dragon boat teams will compete in the event, and the timing (in seconds) of each team will be captured as records in `X`.

Index	1	2	3	4	5
Timing, seconds	58.61	49.01	48.54	59.32	49.78

A segment of the pseudocode to perform bubble sort is given below.

```
Line 1:   flag ← TRUE
Line 2:   WHILE flag = TRUE DO
Line 3:       flag ← FALSE
Line 4:       FOR i = 1 to N //N is the size of array X
Line 5:           IF X[i] > X[i+1]
Line 6:               THEN
Line 7:                   SWAP(X[i], X[i+1])//swaps value of items
Line 8:                   flag ← TRUE
Line 9:           ENDIF
Line 10:      NEXT i
Line 11: ENDWHILE
```

An error is detected in the pseudocode above.

(a) Identify the error by stating the line number, and the type of error.   [2]

(b) **Without** changing the order and the types of constructs used, rectify the error in **(a)**.   [1]

(c) Using the race timings of the dragon boat event given above, use a trace table to illustrate that the amended algorithm works.   [3]

(d) Describe the worst case scenario, and state the worst case time complexity for performing the bubble sort using the algorithm given above.   [2]

(e) In the worst case scenario, state the total number of comparisons made by the bubble sort algorithm if 10 lanes are used.   [1]

2 Every sales transaction made in JPJC supermarket is stored as a record in a serial file for auditing purposes. At the end of each day, a copy of the daily serial file, sorted by transaction amount in descending order will be archived into the main database.

(a) State what is meant by a serial file? [1]

(b) Explain how an archive file is different from a backup file, and describe how a backup file for sales transactions can be created for JPJC supermarket. [2]

Merge sort algorithm is used to arrange the sales transaction records by ordering them in descending order of transaction amounts. The algorithm will first read all the daily unsorted sales transactions into A, a fixed size array of records with index starting from 1. Then, mergesort will be applied to sort A. The pseudocode for mergesort is given below,

```
PROCEDURE mergesort(A: ARRAY of RECORDS, x, y: INTEGERS)
    IF x < y
      THEN
        m ← x + ((y - x) DIV 2) //DIV performs integer division
        mergesort(A, x, m)
        mergesort(A, m + 1, y)
        merge(A, x, m, y)
    ENDIF
ENDPROCEDURE
//---main program---
mergesort(A, x, y)
```

Given that array A = [39.10, 17.50, 35.40, 42.68, 8.90, 35.40], and merge(A, x, m, y) will sort and combine elements of A[x:m], and A[m+1:y] into A[x:y] in descending order.

(c) State the values of x, and y when mergesort is called in the main program. [2]

(d) State the total number of times mergesort and merge are called in the entire program. [2]

The following diagram shows an incomplete trace tree diagram of the array of sales transaction records represented by its sales amount.
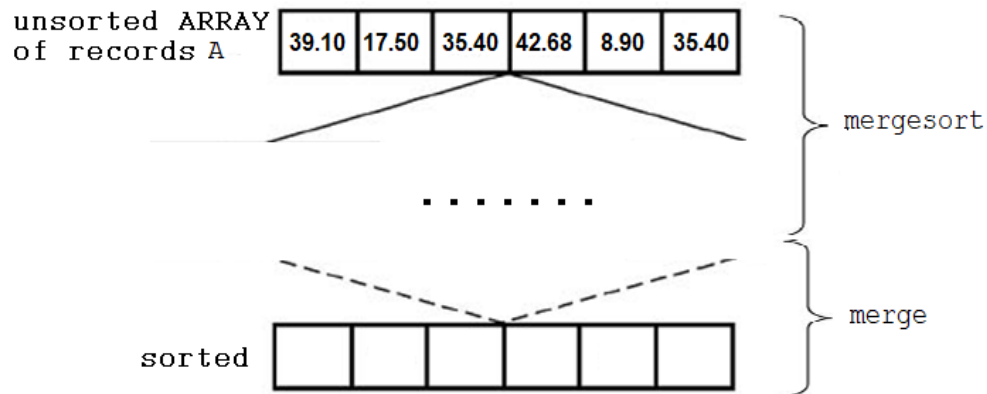
(e) Draw and complete the trace tree diagram above by applying merge sort to the unsorted array of records A. [4]

(f) The time complexity for merge sort is `O(Nlog₂N)`. Explain why this time complexity is applicable to the best, average and worst case scenarios. [1]

3 **(a)** State what is meant by a recursive algorithm? [2]

(b) Explain the difference between an iterative algorithm and a recursive algorithm. [2]

(c) Design a recursive algorithm `SumOfCubes(n)` using pseudocode, that returns the integer value of series

$$1^3 + 2^3 + 3^3 + \dots + (n-1)^3 + n^3, \text{ where } n = 1, 2, 3,\dots$$ [3]

(d) Explain what will happen when the value of `n` gets too large. [1]

4 The elections department of a town wishes to store the records of its voters in a linked list. The stored records are first ordered by the voter's age (in years), followed by voter's name in alphabetical order. The voters list is maintained with the record of the youngest voter at the start of the list.

(a) Explain why the sequence of nodes in a linked list does not always reflect how the data is stored in the memory of the computer. [2]

The following shows the linked list data that is stored in the memory of the computer:

	Age	Name	Link
1	35	Tim Tan	3
2	23	Annie Hao	a
3	45	Bob Boon	6
4	24	Lester Moh	b
5	18	Ari Bello	c
6	52	Helen How	0
7	23	Cindy Ku	d
8	55	Charles Chu	1
9	53	Mimi Lee	e
10	40	Jenny Tsai	f

Head	g
Free	8

Two linked lists are kept to manage the actual data, and the free spaces. When a new item is added, a node is taken from the head of the free space list, and when a node is deleted, the deleted node will be returned to the tail of the free space list.

(b) Given that `Ari Bello` is the youngest voter, state the values of `a`, `b`, `c`, `d`, `e`, `f`, and `g`. [4]

(c) Draw the **linked list diagram** to show its state right after each of the following successive operations:

(i) Insert `18` years old, `Ahmad Ali`.

(ii) Delete `23` years old, `Cindy Ku`.

(iii) Insert `37` years old, `Tania Tan`. [6]

(d) Describe **one** advantage and **one** disadvantage of using a linked list over a static array. [2]

5 The stack is a first in last out data structure where the items are inserted to and deleted from the top of the stack. The items of the stack are globally stored in a fixed length array `S` of size 20. A stack pointer `sp` points to the top item in the stack, and is initialised to 0. The three basic methods of the stack are:

```
PUSH(X) //inserts X as new item on the top of STACK S
POP()   //removes and returns item at the top of STACK S.
PEEK()  //returns value of the item on top of STACK S without
           removing it.
```

(a) Write the pseudocode for the algorithms `PUSH(X)`, `POP()`, and `PEEK()`. [5]

[Turn over

The precedence order of the operators from highest to lowest is as follows:

1. Parenthesis

2. '^'

3. '*' or '/' with equivalent level of priority

4. '+' or '-' with equivalent level of priority

The pseudocode below shows a stack-based function `InfixToPostfix` that converts and returns an input expression represented in infix notation to its postfix form.

```
FUNCTION InfixToPostfix(infix: STRING) RETURNS postfix
  Scan through infix expression one token at a time from leftmost.
  Initialise empty STACK S
  Initialise empty STRING postfix
  FOR token read from infix item by item
    CASE of token:
      operand:  postfix ← postfix + token
      '(':      PUSH(token)
      ')':      REPEAT postfix ← postfix + POP() UNTIL POP() = '('
      operator:
                WHILE S not empty
                  IF token = '(' THEN
                      BREAK
                  ENDIF
                  IF PEEK() is higher or equal precedence than token THEN
                      postfix ← postfix + POP()
                  ENDIF
                ENDWHILE
                PUSH(token)
    END CASE
  NEXT token
  REPEAT
    postfix ← postfix + POP()
  UNTIL S is empty
  RETURN postfix
ENDFUNCTION
```
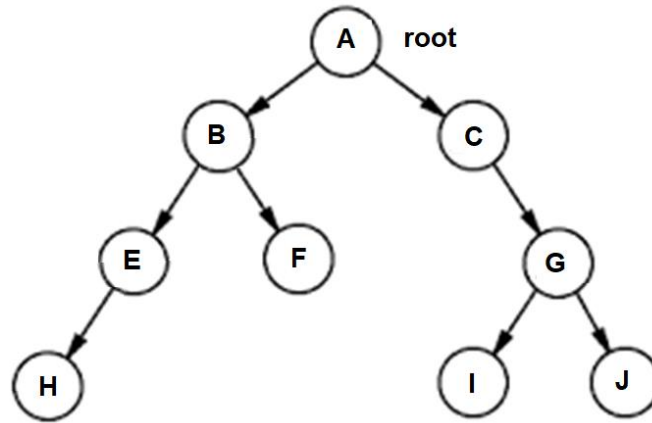
(b) Complete the trace table given below for `InfixToPostfix("A/(B-C)*D^E")`.

token	Description	STRING postfix	Stack, S
A	Appends to postfix	"A"	empty
/	Push to S	"A"	/
(	Push to S	"A"	/,(
...	....	....	....

[4]

(c) Show, with the aid of diagrams, how the computer uses a stack to directly evaluate the value of the postfix expression `895-/12+*4-`. [3]

6 Traversal was performed on the binary tree given below.

(a) List the nodes, in the order, that are visited for,

   (i) in-order traversal, [1]

   (ii) pre-order traversal, and [1]

   (iii) post-order traversal. [1]

(b) A binary search tree is considered as an ordered binary tree where the key values of nodes in the left sub-tree are less than the value of its parent (root) node's key, and key values of nodes in the right sub-tree are greater than the value of its parent (root) node's key.

   (i) Explain how a recursive algorithm can be used to locate a node with key value `search_key` by returning `TRUE` when `search_key` is found, and `FALSE` otherwise. [4]

   (ii) State **one** advantage of using binary search tree as data structure over linked list, and describe a situation that would negate this advantage. [2]

[Turn over

7 Car owners who wish to purchase or renew their insurance policy with XYZ Motor Insurance are required to accumulate not more than 6 demerit points in their driving records. Under this demerit points system, a driver who clocks up more than 20 demerit points will have his/her driving license revoked, thus denying the person from driving and from purchasing any vehicle insurance. Drivers who have not made any insurance claims for the past 3 years can get 2 demerit points off, and current employees of XYZ Motor Insurance can get 1 demerit point deducted. In addition, drivers awarded with certificate of merit can get 1 demerit point off as well. XYZ Motor Insurance only allows drivers to receive a maximum deduction of 3 demerit points per year. Draw a decision table to reflect the eligibility of car owners who wish to purchase or renew a car insurance policy with XYZ Motor Insurance. [5]

8 A company currently uses a computerised flat file to keep track of the monthly claims submitted by its employee, and has decided to use a relational database to store and manage the claims submitted by the employees instead. The following table shows the details of the computerised flat file.

Claims ID	Item Description	Staff ID	Staff Name	Department	Amount
2818	Phone charger	P212	John Lee	Production	$53.23
3291	Car Transport	S281	Chan, Molly	Sales	$31.40
3998	Meal, Lunch	O323	Omar Hairi	Operations	$7.20
4820	AAA Batteries	E493	Muthu K.	Engineering	$10.17
6322	Hard Drive 3TB	A550	Jervois F.	Accounts	$27.99
7384	Medical	M438	Zudin B Ali	Marketing	$48.00
….	….	….		….	….

(a) State and justify **one** reason made by the company to migrate its claims information from the existing flat file system to a relational database management system. [2]

(b) State **two** other fields which would be useful for the company to capture. [2]

(c) Given that the every claim is associated with one item, write the table descriptions of the relational database in **first normal form** and **second normal form**. You are to include the fields in **(b)**. [4]

9 **(a)** What is the denary value of hexadecimal ABCD? [2]

(b) An integer variable of size 4 bytes is used to keep track of the number of commuters who travel to work from Jurong bus interchange. State the maximum number of commuters this variable can keep track. [3]

10 A program written using object-oriented programming has `point`, `circle`, and `cone` as its defined classes. The following diagram below shows the attributes and methods of the class `point`.

```
point
Properties:
PROTECTED:
x-value: REAL
y-value: REAL
Methods:
PUBLIC:
constructor()
getCoordinates(): TUPLE
setCoordinates(x, y: REAL)
```

(a) Draw an inheritance diagram for **all** the **three** classes defined in the program. [4]

(b) Explain the differences between

    (i) private and protected attributes/ methods of a class, [2]

    (ii) an object and a class. [2]

11 A clinic manages patients' medical and financial records through an Internet-based information management portal. Due to several security incidents related to unintended disclosure of patients' information, the clinic's management has decided to migrate the portal to a local area network (LAN) that consists only **four** computers and **one** printer. Information of patients' medical and financial records can only be accessed by authorised staff on one of the four computers.

(a) Describe the meaning of the term local area network (LAN). [2]

(b) Explain why ring networks today rarely use physical layout of a ring? [2]

(c) Describe the functions of a multi-station access unit used in a Token Ring network. [3]

(d) Describe how token passing enables a computer to send data to the printer in this Token Ring network. [3]

END OF PAPER

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