RIVER VALLEY HIGH SCHOOL
General Certificate of Education Advanced Level
Higher 2
J2 Prelim

COMPUTING

Paper 1

9569/01
11 Sep 2024
3 hours

READ THESE INSTRUCTIONS FIRST

Write your center number, index number and name 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, graphs, tables or rough working.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions.
Approved calculators are allowed.

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 **11** printed pages.

Answer **all** questions.

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1. In the FDR game, players must flip a coin, draw a card, and roll a die. The prizes awarded depend on the outcomes of these three events:

   - If a player flips a head, draws a spade, and rolls a six, they win a big prize.
   - If a player achieves any two of these three events (flipping a head, drawing a spade, or rolling a six), they win a small prize.

   a) Draw a reduced decision of the above. [6]

   Study the pseudocode below carefully.

```
01  FUNCTION sieve_eratosthenes(n : INTEGER) RETURNS ARRAY OF INTEGER

      //PART 1
02    DECLARE sieve : ARRAY OF BOOLEAN WITH SIZE n + 1
03    INITIALISE ALL ELEMENTS OF sieve TO TRUE
04    SET sieve[0] TO FALSE
05    SET sieve[1] TO FALSE
06    FOR i FROM 2 TO SQUARE ROOT OF n + 1
07        IF sieve[i] IS TRUE THEN
08            FOR multiple FROM i * i TO n + 1 STEP i
09                SET sieve[multiple] TO FALSE
10            ENDFOR
11        ENDIF
12    ENDFOR

      //PART 2
13    DECLARE primes : ARRAY OF INTEGER of SIZE 0
14    INITIALISE index TO 0
15    FOR i FROM 2 TO n
16        IF sieve[i] IS TRUE THEN
17            INCREASE SIZE OF primes BY 1
18            SET primes[index] TO i
19            INCREASE index BY 1
20        ENDIF
21    ENDFOR
22    RETURN primes

23  ENDFUNCTION
```

   b) Draw a flow chart for the part 1 of the pseudocode above. [6]

   c) State the line(s) where static memory allocation happens. [1]

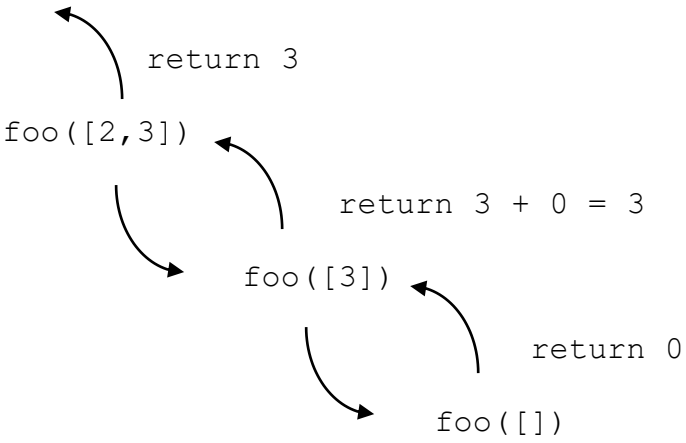
   d) State the line where dynamic memory allocation happens. [1]

   e) Explain why dynamic memory allocation is used in the context above. [1]

2. Study the recursive function below.

```
def foo(num_lst):
    if num_lst:
        # Remove and return the 1st item of num_lst
        temp = num_lst.pop(0)
        if len(num_lst)%2 == 0:
            return temp + foo(num_lst)
        else:
            return foo(num_lst)
    else:
        return 0
```

a) An example of a trace tree diagram showing the recursive function call `foo([2,3])` is shown as follows:



Use the above example to create a trace tree diagram for the recursive function call `foo([1,2,3,4,5])`. [3]

b) Write in pseudocode the iterative version of `foo(num_lst)`. [3]

c) Identify all the sorting algorithms below.
   a. This sorting method works by taking each item in a list one by one and placing it in its correct position among the items already sorted.
   b. This sorting method works by dividing a list into smaller chunks, sorting each chunk, and then combining the sorted chunks into a single, sorted list.
   c. This sorting method works by choosing a key item in a list and partitioning the other items into two groups: those less than the key and those greater. We then repeat this process with each group, choosing a new key and partitioning the items again, until the entire list is sorted.
   d. This sorting method works by repeatedly going through a list and swapping adjacent items if they are in the wrong order. [2]

d) What are the specific conditions under which a simple sorting algorithm would perform better than a complex sorting algorithm? [2]

3. You want to create a simple phone contact book that stores names and phone numbers for a collection of contacts, approximately 500 in total, with a fixed maximum limit of 500 entries. You decide to use an array to store the contacts, where each element of the array represents a single contact. To optimize storage and minimize empty gaps:

   - The array has a fixed size of 500 entries.
   - When a contact is added, it will be placed at the first empty slot in the array, if available. If the array is full, no new contacts can be added.
   - When a contact is deleted, the last contact entry in the array will replace the deleted contact and the last contact entry slot is then freed up.

   Part of the array structure is as follow:
   contacts[0] = ["John Doe", "123-456-7890"]
   contacts[1] = ["Zen Smith", "987-654-3210"]
   contacts[2] = ["Bob Johnson", "555-123-4567"]
   …

   a) State the time complexity of searching for a contact by name in the phone contact book array. Justify your answer. [2]

   b) How would you modify the addition and deletion operations in the phone contact book array to enable the use of binary search for finding contacts by name, while maintaining a fixed array size of 500 entries? [2]

   c) State the advantage of using a hash table to store the contact instead. [1]

   d) Suggest a possible hash function for this hash table. [1]

   e) Suggest a possible hash table size. Justify your answer. [1]

   f) State 3 characteristic of a good hash function. [3]

4. You are a software tester for a banking application that allows users to transfer funds between accounts. The application has a "Transfer Funds" feature with the following requirements:

   - Source Account Number
     - a text field that only accepts a valid 10-digit account number
   - Destination Account Number
     - a text field that only accepts a valid 10-digit account number
   - Transfer Amount (numeric field):
     - Minimum transfer amount: $10
     - Maximum transfer amount: $10,000
     - Must be a multiple of $1 (no cents)

   The application should validate the inputs and perform the transfer if the inputs are valid. The application should also display an error message if the inputs are invalid. After a successful transfer, the application will display:

   - The source account balance (updated)
   - A success message indicating the transfer amount and destination account number
   - The destination account balance will NOT be displayed for privacy reasons

   a) State one data validation technique and one data verification technique for the source and destination account number input. [2]

   b) Design a series of test cases to test the "Transfer Funds" feature completely. You can assume that the Source Account Number is valid. [4]

   c) State 1 key difference between white box and black box testing. [1]

   The transfer pseudocode is as follows.

```
PROCEDURE Transfer (src_acc, des_acc, amount)
    IF src_acc.balance >= amount THEN
        src_acc.balance := src_acc.balance - amount
        IF src_acc <> des_acc THEN
            des_acc.balance := des_acc.balance + amount
        END IF
    END IF
END PROCEDURE
```

   d) State the issue faced by a mistrustful user who always like to transfer a small amount of funds to themselves before carrying out the actual transfer. [1]

   e) State the type of error for the above. [1]

   f) Explain how you can fix the issue without editing the transfer code. [1]

The banking application is developed by a few developers. A software version control system is used during the development.

g) State 2 advantages of using a software version control system in software development. [2]

5. Study the 4 scenarios below carefully.

Scenario 1: Job Scheduling System
In a job scheduling system, tasks are added to a data structure and processed in the order they are received.

Scenario 2: Music Playlist Editor
A music playlist editor application uses a data structure to manage a user's favorite songs. Users can insert a new song between two existing songs and remove a song from the middle of the playlist.

Scenario 3: File System Directory Management
A file system directory management needs to manage many files and directories. Fast lookup, insertion, and deletion of files and directories, as well as efficient traversal of the directory structure, are required.

Scenario 4: Image Processing Application
An image processing application needs to store a fixed-size buffer of pixel values for an image. The buffer has a fixed size, and we need to access and manipulate pixel values randomly.

a) State the most appropriate data structure for each scenario above. [4]

b) State the condition where a static data structure is preferred over a dynamic data structure. [1]

A BST that is used to stored integers in order is designed with the left subtree containing larger integers than the right subtree. The following integers are inserted into the BST in the same order as shown.

5, 4, 2, 8, 7, 6, 3, 1

c) Draw the logical BST as described above. [1]

d) State the post order traversal of the BST above. Take note that the right subtree is to be traversed before the left subtree. [2]

6. Answer all the question.

   a) State 2 key features of the Transmission Control Protocol (TCP) in terms of data delivery between applications? [2]

   b) State two advantage(s) of sending data in smaller segments in computer networking. [2]

   c) Describe the three main steps involved in a switch's packet-forwarding process. [3]

   Company Y, a financial services firm, has a network of 500 employees. One employee, Sarah, uses her company-issued laptop for both work and personal activities. While working from home, Sarah's laptop is infected with malware through a phishing email that appears to be from a legitimate online shopping website. The email prompts her to download a fake software update, which installs a keylogger and remote access Trojan (RAT) on her laptop. Sarah is not aware of the malware installation and the malware lies dormant for weeks, allowing the attacker to gather sensitive information, including login credentials and financial data. Eventually, the attacker uses the RAT to gain access to Company Y's network, compromising sensitive financial data and causing significant disruption to business operations.

   d) State one specific guideline or principle of the code of conduct for IT professionals that Sarah failed to uphold in her actions. [1]

   e) State what company Y should do to prevent such incident. [2]

7. Read the following description.

   "This is a conceptual system for representing and modeling computing devices, such as laptops and handphones, in an object-oriented programming (OOP) context. The system consists of several classes that work together to capture the characteristics and behaviors of these devices.

   Firstly, the CPU is represented by a class that captures its brand, model, and speed.

   The Computer class serves as a foundation for all computing devices. It has attributes CPU, memory, storage, and a Boolean flag to indicate whether the device is on or off. It also provides methods for starting and shutting down the device, as well as connecting to a network.

   Laptops and handphones are two types of devices that share all the characteristics with computers. They have additional attributes, such as keyboard type and battery life for laptops, and camera and battery life for handphones. Interestingly, they also have distinct ways of connecting to a network."

a) By examining the attributes and methods of these classes, draw the UML class diagram. [6]

b) Explain what polymorphism is. Circle the polymorphed functions. [2]

c) Explain what data encapsulation is. Give an example using the example given. [2]

8. Ang Mo Tan town council is building BBQ pits in various of its residential estates for residents to book to help provide facilities that will improve social cohesion. The BBQ pits will be grouped according to the residential committee (RC) zone within the town and the bookings will be made through the corresponding residential committee office.

The contact information of residents will be recorded on first booking to keep the system simple and to avoid maintaining a large database of residents. The last 5 characters of NRIC will also be recorded for verification purposes on the day of pit usage.

As part of the developer team on this project, your task is to set up a database to manage bookings of the BBQ pits. Using relational database, you draft out the following tables with sample data for the booking process:

- `BBQ Pits`: information for the BBQ pits
- `Residents`: particulars of the residents making a booking
- `Bookings`: details of the bookings

BBQ Pits

Pit ID	Description	RC Zone	RC Address
pit01	In front of Blk 118	Palmtree RN	117, Ang Mo Tan Ave 8, #01-285, 123117
pit02	In front of Blk 118	Palmtree RN	117, Ang Mo Tan Ave 8, #01-285, 123117
pit03	on top of carpark 250	Raintree RN	253, Ang Mo Tan Ave 5, #02-110, 125250
pit04	Blk 255 bridging garden	Raintree RN	253, Ang Mo Tan Ave 5, #02-110, 125250
...	...	...	...

Residents

ID	Name	NRIC Last 5	Contact
AMT0001	Lim Peh	1546K	81234567
AMT0002	Tan Jingu	2354L	91234588
AMT0003	Kau Bu	5486D	92345878
…	…	….	…

Bookings

Booking ID	Pit	ID	Date of Use	Start Time	End Time
20240001	pit01	AMT0001	28112024	1800	2300
20240002	pit03	AMT0002	29112024	1700	2200
20240003	pit04	AMT0003	27112024	1900	2359
…	…	…	…	…	…

a) Explain the main aim for normalisation in a relational database. [1]

b) What is one possible issue when using tables that are not normalised in a relational database? Provide your answer with case example. [1]

c) State with reasons if the tables in the above tables are in 3rd Normal Form? [2]

d) A table description can be expressed as

```
Tablename (Attribute1, Attribute2, Attribute3, …)
          ----------
```

The primary key is indicated by underlining one or more attributes. Foreign keys are indicated using a dashed underline.

Write table descriptions of the normalised tables in the database. If additional table(s) are needed for normalisation, do provide suitable tablename for the new table(s) which make use of the Primary Key column name.

Provide suitable Primary Key and indicate the Foreign Key for each table. [8]

e) Draw out the entity-relationship (ER) diagram for the normalized tables in the database. [7]

The booking process involves the resident coming down to the RC office to request a booking with the RC Manager. The RC manager will assess the residential status and the intent of the booking through physical and verbal checks. The RC manager will then book the pit under the name of the resident within the system.

f) There are plans to put the system online for the residents to make the booking. State a possible social issue which the developer must consider and address before moving the system online. [1]

The launch of the online booking system proves to be effective in improving the efficiency of the booking process as evident from the increasing number of bookings made by residents. The town council thus suggest to expand the booking system to other facilities such as RC activity rooms and community garden plots etc.

With this plan moving forward, the developer team decided to migrate the current relational database to a NoSQL database (MongoDB).

g) Provide 2 explanations on why the developer team decided to migrate to NoSQL database. [2]

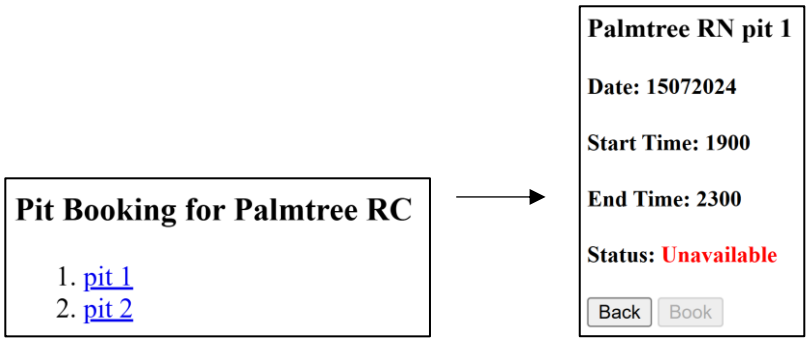
The following is a sample json document file that is sent to the booking system database for booking of a BBQ pit:

```
{
  "bookingid": "20240001",
  "residentname": "Lim Peh",
  "nriclast5": "5154D",
  "type": "pit",
  "booking": {
        "pit_id": "pit_1",
        "dateofuse": "15072024",
        "starttime": "1700",
        "endtime": "2300"
        }
}
```

The fields of the pit booking document correspond to the column name used in the earlier relational database tables. There is an additional field “type” which indicates that this document is for booking of BBQ pit.

h) Write down the mongodb query to return all documents for bookings of BBQ pit made for use on the date `"15072024"`. You may assume your own database and collection name which the document is placed. [1]

The first draft of the online system for booking of the BBQ pit involves 2 webpages as shown below after entering the details of the booking RC location, date and time:



Page 1 Page 2

Clicking on the pit id link in page 1 will lead to page 2 for the corresponding pit id. If the pit is available then the resident can proceed to book. Otherwise, the resident will need to navigate back from page 2 to page 1 to reselect another pit id link.

i) Write down the usability issue with the above process and state the associated principle. [2]

End of Paper