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|  | NATIONAL JUNIOR COLLEGE  Mathematics Department  General Certificate of Education Advanced Level  Higher 2 | | | |
| **COMPUTING** | | | | **9569/1/2**  **9 July 2020**  **3 hours** |
| Additional Materials: | |  | Pre-printed A4 Answer Booklet  Electronic version of PARTICIPANTS.TXT data file  Electronic version of T3.py Python code file  Insert Quick Reference Guide | |
| **READ THESE INSTRUCTIONS FIRST**  Answer **all** questions**.**  This paper consist of **two** parts.  Part 1: Theory (60 marks)  There are five questions in this part.  Answers to be submitted in the answer booklet provided.  Part 2 : Practical (40 marks)  There are three tasks in this part.  All tasks must be done in the computer laboratory. You are not allowed to bring in or take out any pieces of work or materials on paper or electronic media or in any other form.  Save each task as it is completed.  Approved calculators are allowed.  The use of built-in functions, where appropriate, is allowed for this paper unless stated otherwise.  The number of marks is given in the brackets [ ] at the end of each question or part question.  The total number of marks for this paper is 100. | | | | |
| This document consists of **12** printed pages and 0 blank pages.  NJC Mathematics 2020 **[Turn over** | | | | |

**Part 1: Theory**

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| **1.** | In the Windows operating system, we can create restore points to help us recover data up to a particular point in time. For example, if you create a restore point on 1st, June 2020 at 9:00am, you will be able to recover the data on your hard disk such that the disk will contain the data at that particilar point in time.  You can create as many restore points as you want until the operating system reports that there is insufficient resources.  You can restore only to the latest restore point. For example, if the following restore points represented as (date in dd/mm/yy, time in 24 hour hhmm format) are shown in reverse order of the time that they are created:  (1/6/2020, 1300), (1/6/2020,0900), (2/4/2020,0700).  You can restore your disk to (1/6/2020, 1300) first, then to (1/6/2020,0900) and so on.  Restore points are removed once the disk has been restored to that restore point.  Assume that the contents of a hard disk is represented as an ARRAY of BLOCK, where a BLOCK is an abstract data type that represents 1 Mega Bytes (1M) of data. So a 1 Giga Bytes (1GB) hard disk can be represented as an ARRAY of 1000 BLOCK. Operations on the hard disk are performed at the BLOCK level and can be represented with the following two functions:  WRITE(Data: BLOCK, Address: INTEGER), where Data is the 1M of data to be written to disk and Address is the index of the array where the data is to be written.  READ(Address): RETURNS Data, where Data is the 1M of data to be returned and Address is the index of the array where the data is to be read from.  After a restore point is created, the operating system will monitor all the disk write operations such that **before** the contents of the hard disk is overwritten, a backup operation will be performed to read the BLOCK of data from the disk and stored it in a separate data structure/s. You do not need to consider how that data structure/s is to be persisted on disk. | | |
|  | **(a)** | Describe the **data structure/s** that may be used by the backup operation described above. You may use any diagrams/UML class diagrams in your descriptions. You may reference the functions and abstract data type described above.  Explain why you use the data structure/s that you have chosen. | [5] |
|  | **(b)** | Explain using structured English or pseudocode, how the data structures/s that you have chosen in **1(a)** is used to perform a restore of the contents of a hard disk to a particular restore point. You may reference the functions and abstract data type describes above. | [2] |

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| **2.** | A company has decided to offer an in-house credit system by issuing privileged customers an in-house credit-card which allows customers to charge their purchases from the stores to the card, up to the customers’ credit limits. | | |
|  | **(a)** | During a sales promotion, the store offers a discount of 15% if a customer’s total purchase is greater or equal to $200 but less than $500. A discount of 20% is given if the customer’s total purchase is greater or equal to $500. For customers who had exceeded their credit limits, the supervisor’s approval is required.  Create a decision table or tree to represent the above conditions and actions. | [4] |
|  | **(b)** | Describe the scenario in **2(a)** using a flow chart | [3] |
|  | **(c)** | When customers apply for an in-house credit-card, they have to provide the company with their personal information.  In order to protect the privacy of data, many countries have passed legislation to address this issue.  Describe any 3 features of the Personal Data Protection Act in Singapore that aims to do this. | [3] |

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| **3.** | **(a)** | Database management systems provide manay features that can solve problems associated with traditional file-based systems. Describe three database management system features and explain how they are use to solve the problems in traditional file-based systems. | | [6] |
|  | **(b)** | A national car hire company uses a relational database to manage its car rentals. The company has a large number of depots around the country where customers can rent their cars from. They can rent their cars from any depot and return their rental cars to any depot. | |  |
|  |  | **(i)** | Draw an Entity-Relationship Diagram (ERD) to model the entities and their relationships in 3NF. | [4] |
|  |  | **(ii)** | Describe the entities and their attributes. You must indicate the primary keys and foreign keys using appropiate notations. | [4] |
|  | **(c)** | The company spent a very large proportion of its IT budget on maintaing the hardware and software for its database. Th management is considering a proposal to migrate its database to the cloud by using a service provider's Platform as a service (PaaS). | |  |
|  |  | **(i)** | What is PaaS? | [2] |
|  |  | **(ii)** | How does migrating its database to the cloud reduce cost ? | [2] |
|  |  | **(iii)** | Identify two disadvantages of using a cloud-based database service | [2] |

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| **4.** | A linked list Abstract Data Type ADT with the following incomplete UML class diagram specification is given as follows:   |  | | --- | | Node | | -data:OBJECT  +nextPtr:Node | | constructor()  setData(s:OBJECT)  getData():OBJECT |  |  | | --- | | LList | | +head:Node | | +constructor()  +insertFront(n:Node)  +findMiddle():Node | | | | |
|  | **(a)** | Explain the main difference between an array and a linked list data structure. | [2] | |
|  | **(b)** | Using pseudo code, write an algorithm to implement findMiddle that will return the Node in the middle of the linked list in **one pass**. | [5] | |
|  | **(c)** | Another frequently use ADT is a Queue which can be described as follows:   |  | | --- | | Queue | | -buffer: LList | | +enqueue(n:Node)  +dequeue():Node | | |  | |
|  |  | In order to implement the enqueue and dequeue operations, one or more methods need/s to be implemented in the LList class. Define the method/s name (including the parameter/s) and describe how the method/s work/s in structured English. | | [4] | |
|  | **(d)** | State one other application of a linked list other than being used in a queue or stack. | | [1] | |

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| **5** | A user types the following URL on the web browser's address bar:  http://microbit.org/code/ | | |
|  | **(a)** | Identify the different parts in the URL above and explain what does each part means. | [3] |
|  | **(b)** | In the context of network communication, explain what is a protocol? | [2] |
|  | **(c)** | Describe the internal communication processes that occur after the URL is entered till the web page is rendered on the user's web browser. You should focus on the protocol/s and addresses being used and the different components that are involved in the communication process. | [6] |
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**Part 2: Practical**

**Instructions to candidates:**

Copy the folder from the thumb drive to the PC's desktop and rename the folder on the desktop to <your name>\_<NRIC number>.(For example, TanKengHan\_T0123456A).

All the resource files are found in the folder and you should work on the folder in the desktop.

Your program code and output for each of Task 1 to 3 should be saved in a single .ipynb file. For example, your program code and output for Task 1 should be saved as

Task\_1\_<your name>\_<NRIC number>.ipynb.

You should have a total of **three** .ipynb files to submit at the end of the paper.

At the end of the exam, copy the working folder on your desktop to the thumb drive.

**Task 1**

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| In a software development hackathon competition, participants are being assigned different roles. The participants information is stored in a file, PARTICIPANTS.TXT There are three fields on each line which indicates name, role and gender. The fields are separated by ‘;’  Rufus Schuck;Coder;F  Ione Wolfe;Manager;F  Hillary Curl;Tester;M  …  For each sub-task, add a comment statement, at the beginning of the code using the hash symbol "#", to indicate the sub-task the program code belongs to, for example:   |  |  |  | | --- | --- | --- | | In [1]: | |  | | --- | | *#Task 1.1*  Program code |   Output: |   The file provied is PARTICIPANTS.TXT | |
| **Task 1.1**  Implement the function read\_data(filename) which takes filename as a string and returns a 2-dimension Python list that follows the format as shown in the example below.  >>> read\_data("PARTICIPANTS.TXT")  [['Rufus Schuck', 'Coder', 'F'],  ['Ione Wolfe', 'Manager', 'F'],  ['Hillary Curl', 'Tester', 'M'],…]  Take note that the list shown above is just an example.  This list shown above is known as the participants list and it contains a list of participants' records. | [2] |
| **Task 1.2**  Implement the function  gender\_count(participants)  which takes a list participants, obtained in **Task 1.1** and returns the number of male and female participants.  The following shows an example of how the function Is used.  >>> participants = read\_data("PARTICIPANTS.TXT")  >>> number\_males, number\_females = gender\_count(participants)  >>> print(number\_males, number\_females)  17 33 | [3] |
| **Task 1.3**  Implement the function  role\_statistics(participants)  which takes a list participants obtained in **Task 1.1** as input and outputs the number of students for each role in the following format.  The following shows an example of how the function Is used.  >>> participants = read\_data("PARTICIPANTS.TXT")  >>> role\_statistics(participants)  Role Number  Coder 7  Manager 13  Maker 11  Designer 11  Tester 7  Snakeeater 1 | [4] |
| **Task 1.4**  Implement the function  form\_group(participants)  which takes a list participants obtained in **Task 1.1** as input and returnsa list consisting of 5 participants’ records. This list of participants forms a group and must consist of **one coder, one maker, one tester, one manager and one designer**. The participants picked for each role must be random. The five participants that forms the group must have their corresponding records removed from the participants list.  If there is not sufficient roles or participants to form a group, return an empty list.  The following shows an example of how the function Is used.  >>> participants = read\_data("PARTICIPANTS.TXT")  >>> form\_random\_group(participants)  [['Shaunda Sieg', 'Coder', 'F'],  ['Darlena Crimi', 'Manager', 'F'],  ['Phyliss Rolen', 'Maker', 'M'],  ['Russell Gillison', 'Designer', 'F'],  ['Kathlene Collar', 'Tester', 'M']]  Note:  'Shaunda Sieg'is a Coder  'Darlena Crimi'is a Manager  'Phyliss Rolen'is a Maker  ''Russell Gillison' is a Designer  'Kathlene Collar' is a Tester | [10] |
| **Task 1.5**  Using your solutions in the previous tasks, write Python code to form as many groups from the participants list obtained in **Task 1.1** and output the groups to a file GROUPS.TXT  The file should also include a Group Number for each group formed. An example of how the file should look like is as follows:  Group 1  Toney Mcnab,Coder,M  Luanne Lett,Manager,F  See Borne,Maker,F  Laverna Halpern,Designer,F  Chadwick Griffin,Tester,M  Group 2  Fredricka Gormley,Coder,F  Ashely Faye,Manager,M  Phyliss Rolen,Maker,M  Carolann Kintner,Designer,M  Reiko Stack,Tester,F  Group 3  Rufus Schuck,Coder,F  Odis Levalley,Manager,M  Teodoro Negrin,Maker,F  Russell Gillison,Designer,F  Apryl Soileau,Tester,F  Group 4  Angle Linck,Coder,F  Johnna Lecuyer,Manager,F  Tashia Bowen,Maker,F  Grazyna Kitzman,Designer,M  Kathlene Collar,Tester,M | [5] |
| Save your file as Task\_1\_<your name>\_<NRIC number>.ipynb. |  |

**Task 2**

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| A minimal heap is a binary tree (**NOT BST**) that always maintains the smallest data item at its root node. In this question, the class MinHeap is implemented using a 1D array with each child node index calculated using the following formula.:  left\_child\_ptr = node\_ptr x 2 + 1  right\_child\_ptr = node\_ptr x 2 + 2  Note that the pointers are actually the indexes on the array.   |  |  | | --- | --- | | **class MinHeap attributes** | **Description** | | count: INTEGER | It stores the number of data item currently in minheap. | | size: INTEGER | It stores the maximum number of data item minHeap can take. | | tree: ARRAY[0:N-1] OF INTEGER | It is a 1D array that stores the data items as nodes in minHeap. If a data item doesn’t exist, it is represented by -1. N, the number of nodes, is passed as an argument in the constructor of the class.  You can assume that the data stored in the tree are all positive integers. |   For each sub-task, add a comment statement, at the beginning of the code using the hash symbol "#", to indicate the sub-task the program code belongs to, for example:   |  |  |  | | --- | --- | --- | | In [1]: | |  | | --- | | *#Task 1.1*  Program code |   Output: | | |
| **Task 2.1**  The **incomplete** pseudo-code to add a new item into the MinHeap is described by the function add(minHeap,newItem) shown below.  FUNCTION add(minHeap: MinHeap, newItem:INTEGER)  // IS\_NOT\_FULL() returns True  IF IS\_NOT\_FULL(minHeap) THEN // if minHeap is not full  minHeap.tree[count] 🡨 newItem  curr\_ptr 🡨 minHeap.count  parent\_ptr 🡨 (curr\_ptr - 1) DIV 2    WHILE curr\_ptr <> 0 AND minHrap.tree[parent\_ptr] > newItem  **// MISSING PSEUDO-CODE**    ENDWHILE    INCREMENT minHeap.count BY 1  ELSE  OUTPUT "Heap is full. Cannot add."  END IF  ENDFUNCTION  Write the Python code to implement the class MinHeap and its method add | [3] |
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| **Task 2.2**  The class method remove\_minimum is implemented for you in file T3.py. This function removes the data item at the root node of the minimum heap and returns the data item. You may copy the code in T3.py into your own code.  Your task is to implement the class method sort which returns a list consists of all the data items stored in the minimum heap in increasing order. Take note that after sort is executed, the minimum heap becomes empty.  An example of a test script is as follows:  test\_values = [58, 36, 3, 9, 87]  h1 = MinHeap(len(test\_values))  for value in test\_value:  h1.add(value)  print(h1.sort())    Output:  [3, 9, 36, 58, 87] | [3] |
| **Task 2.3**  Implement the class method display\_all\_paths which displays all paths from the root of minimum heap to all its leaves. *Hint: The minimum heap in this question is implemented using a complete binary tree. This means that the tree array indices from 0 to count-1 contain all the data items of the minimum heap.*  An example of how MinHeap works is shown in the test script below:  test\_values = [9,5,6,7,8,1]  h1 = MinHeap(n)  for value in test\_values:  h1.add(value)  h1. display\_all\_paths()  Output:  1 7 9  1 7 8  1 5 6 | [4] |
| Save your file as Task\_2\_<your name>\_<NRIC number>.ipynb. |  |

**Task 3**

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| Implement a recursive function in Python code to compute the summation of a geometric series:  image  The final program shouldl print out   * All items, separated in whitespace, in the series. * Summation of the series   For example, the inputs for a, r and m are as follows:  1  2  10  Your final program should print  2 4 8 16 32 64 128 256 512 1024  2046 | [6] |
| Save your file as Task\_3\_<your name>\_<NRIC number>.ipynb. |  |

**END OF PAPER**