**NATIONAL UNIVERSITY OF SINGAPORE**

**SCHOOL OF COMPUTING**

**MIDTERM TEST FOR**

**Semester 1, AY2020/21**

**CS2040C – Data Structures and Algorithms**

30 September 2020 Time allowed: 1.5 hours

**0C**

**K**

**M**

STUDENT **NO. :**

**INSTRUCTIONS TO CANDIDATES**

1. Copy the ans\_blank.txt text file and rename it to <your NUSNET ID>.txt  
   e.g. e0123456.txt. Write your **student number** and **NUSNET ID** within the appropriate tags of the copied file. Ensure you **answer question 0** as instructed. Failure to do so will prevent your submission from being graded
2. This is an open-hardcopy-notes examination but **WITHOUT** electronic materials
3. It is your responsibility to ensure that you have submitted the correct file with the correct particulars and format. If you submit the wrong file, name the file incorrectly, fail to provide correct particulars or change the contents of the file such that it cannot be parsed, we will consider it as if you did not submit your answers. In the best case, marks will be deducted
4. No extra time will be given at the end of the test for you to write your particulars. You must do it **before** the end of the test. However, you may upload your file after the end of the test
5. This paper consists of **5** inline questions including Q0, and **1** multiline question. It comprises seven (**7**) printed pages including this front page
6. Answer all questions within the text file. **Inline** answers should be appended to the end of each #Qx: part on the **same line**. Multiline answers should be **written between** the appropriate tags with **proper indentation** and adhering to the line limit. Avoid using the # character in both cases. Do NOT add, modify, remove any tag
7. Marks allocated to each question are indicated. Total marks for the paper is **45**
8. The use of electronic **calculator** is **NOT** allowed

|  |  |  |
| --- | --- | --- |
| ***Question*** | ***Max*** | ***Marks*** |
| Q0 | Min -45 |  |
| Q1abcd | 8 |  |
| Q2abc | 6 |  |
| Q3abc | 9 |  |
| Q4 | 6 |  |
| Q5ab | 16 |  |
| ***Total*** | **45** |  |

**Question 0 [0 for ENTIRE PAPER if not done satisfactorily!]**

Please read the following NUS Code of Student Conduct (in particular the part on Academic, Professional and Personal Integrity), as well as items B and C below.

(A) **I am aware of, and will abide by the NUS Code of Student Conduct (in particular the part on Academic, Professional and Personal Integrity as shown below) when attempting this assessment.**

* Academic, Professional and Personal Integrity
  1. The University is committed to nurturing an environment conducive for the exchange of ideas, advancement of knowledge and intellectual development. Academic honesty and integrity are essential conditions for the pursuit and acquisition of knowledge, and the University expects each student to maintain and uphold the highest standards of integrity and academic honesty at all times.
  2. The University takes a strict view of cheating in any form, deceptive fabrication, plagiarism and violation of intellectual property and copyright laws. Any student who is found to have engaged in such misconduct will be subject to disciplinary action by the University.
  3. It is important to note that all students share the responsibility of protecting the academic standards and reputation of the University. This responsibility can extend beyond each student’s own conduct, and can include reporting incidents of suspected academic dishonesty through the appropriate channels. Students who have reasonable grounds to suspect academic dishonesty should raise their concerns directly to the relevant Head of Department, Dean of Faculty, Registrar, Vice Provost or Provost.

(B) **I have read and understood the rules of the assessments as stated below.**

1. Students should attempt the assessments on their own. There should be no discussions or communications, via face to face or communication devices, with any other person during the assessment.
2. Students should not reproduce any assessment materials, e.g. by photography, videography, screenshots, or copying down of questions, etc.

(C) **I understand that by breaching any of the rules above, I would have committed offences under clause 3(l) of the NUS Statute 6, Discipline with Respect to Students which is punishable with disciplinary action under clause 10 or clause 11 of the said statute.**

3) Any student who is alleged to have committed or attempted to commit, or caused or attempted to cause any other person to commit any of the following offences, may be subject to disciplinary proceedings:

l) plagiarism, giving or receiving unauthorised assistance in academic work, or other forms of academic dishonesty.

**To answer Q0, type either your student number or NUSNET ID to declare** that you have **read and will abide** by the NUS Code of Student Conduct (in particular, (a) Academic, Professional and Personal Integrity), (b) and (c).

Ans:

**Question 1 [8 marks, 4 x 2]**

the best algorithm - **max 30 char** (the count excludes spaces and punctuation where used in normal English grammar) - that should be used in each scenario, independent of the other scenarios:

**a)** You have a list of **N** phone numbers, **N** is large, sorted ascending. Find the smallest (supposing phone numbers were treated as integers) phone number within the list that is larger than a given phone number **x**

Ans:

**b)** You have a list of **N** phone numbers, **N** is large, sorted ascending. Find the smallest (supposing phone numbers were treated as integers) phone number **p** within the list such that **p** is larger than a given phone number **x** **AND** **p** is palindromic

Ans:

**c)** Sending **N** packets of data, **N** is very large, over a network, with the receiver informing the sender the ids of the packets that have been received (some packets fail to reach the receiver). There can be at most **K** packets that are sent out but not yet recieved

Ans:

**d)** You have an increasing function **double f(BigInteger x)** , where **x** is positive (and f returns a double value). Suppose that there is no easy way to find the inverse of the function, and you do not know what the function does internally. Find the value of **x** such that **f(x)** = **k** for some double **k**

Ans:

**Question 2 [6 marks, 3 x 2]**

Ivan is of weight **w** and height **h**. After eating **c** candies, Ivan gained weight!

**double** gainWeight(**int** c, **double** w, **int** h) { ... }

Find the time complexity of each of the following implementations of gainWeight(). Remember to use the **correct variable(s)**. Do **NOT provide justification**:

**a)** **while** (h > 0) { ++w; h /= c; }

**return** w;

O(                )

**b)** **if** (h == 0) **return** c;

**return gainWeight**(c, c\*w/(h\*h), h-1) - **gainWeight**(c, c\*w/h, h-1);

O(                )

**c)** **double** nw = 0;

**for** (**int** i = 0; i < c; i++) nw += **gainWeight**(c-1, c\*w/(h\*h), h-1);

**return** nw;

O(                )

The symbol for exponentiation is ^ and the symbol for factorial is !

**Question 3 [9 marks, 3 x 3]**

:--:--:--:--: :

| | Y | |

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:--:--:X :--:--:

Adapted from: https://www.asciiart.eu/art-and-design/mazes

Help a robot traverse a maze from the bottom entrance to the exit on the top right. There is only 1 possible "route", although each route is typically 2 lanes wide (see the space at the right of position **X**). The robot is initially at **X** facing north. Valid commands are:

/(<num>) turns 90 degrees clockwise num times, where num is between 1 to 3

-(<num>) move in the current direction num times

As an example:

-(3)/(1)-(3)/(3)-(2)/(3)-(1)/(3)

will cause the robot to move from **X** to **Y**, end up facing north, keeping left as far as possible along the way

You may notice, the program to give the robot MUST:

* be a series of commands WITHOUT any separator in between commands
* have NO space(s) both within and outside the parentheses

**You will definitely get marks deducted, or even get 0**, if you do not **follow this format STRICTLY**

**Your Tasks**

There are 3 different independent scenarios. In each scenario, write a program for the robot to run from X to the exit using the **format** shown above, **without comments/justification**:

**a)** Every move command must be followed by a turn command

Program:

**b)** Move over as many spots as possible without hitting the same spot twice (and end up at the exit)

Program:

**c)** You can now move through | but NOT through : and --... Reach the exit using the fewest number of commands

Program:

**Question 4 [6 marks]**

Write the output of this code snippet:

cout << " \_\_\_\_\_\_\_" << "\n";

cout << " /\ \" << "\n";

cout << " /()\ () \" << "\n";

cout << "/ \\_\_\_\_\_\_\_\" << "\n";

cout << "\ /() /" << "\n";

cout << " \()/ () /" << "\n";

cout << " \/\_\_\_\_\_()/" << "\n";

cout << "https://www.asciiart.eu/miscellaneous/dice" << "\n";

(This is an **INLINE** question) Ans:

INLINE

ANSWER

**Question 5 [16 marks, 6 + 10]**

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Source: https://www.asciiart.eu/electronics/robots

There is no question here, this is a mock midterm

**a)** Write C++ code to complete the canBeFixed() method which returns whether the robot can be repaired. If there is no error, canBeFixed() should return true

[Line limit **24**] Ans:

MULTILINE

ANSWER

**b)** Write C++ code to complete the repair() method which repairs the robot, if it can be fixed. For bonus credit (+3 marks), this should be done in O(**N**) time

[Line limit **40**] Ans:

MULTILINE

ANSWER

- **End of Paper** -