National University of Singapore

TIC1001—Introduction to Computing and Programming I

Semester 1, 2019/2020

Time allowed: 2 hours

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1. Please write your Student Number only. Do not write your name.
2. The assessment paper contains **FIVE (5) questions** and comprises **TWELVE (12) pages** including this cover page.
3. Weightage of questions is given in square brackets. The maximum attainable score is 60.
4. This is a **OPEN** book assessment. While you are allowed to bring any physical materials and notes, no electronic devices such as tablets, laptops and calculators are allowed.
5. Five additional minutes of reading time will be given before the start of the assessment.You may read the paper but are not allowed to write anything during this time.
6. Write all your answers in the space provided in this booklet.
7. You are allowed to write with pencils, as long as it is legible.
8. **Please write your student number below.**

STUDENT NO:	S	O	L	U	T	I	O	N	S

(This portion is for the examiner's use only)

Question	Marks	Remarks
Q1	/ 16	
Q2	/ 18	
Q3	/ 18	
Q4	/ 6	
Q5	/ 2	
Total	/ 60	

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It may be used as scratch paper.

Question 1: C/C++ Expressions [16 marks]

There are several parts to this question which are to be answered independently and separately. Each part consists of a fragment of C/C++ code. Write the exact output produced by the code in **the answer box**. If an error occurs, or it enters an infinite loop, state and explain why.

You may show workings **outside the answer box** in the space beside the code. Partial marks may be awarded for workings if the final answer is wrong.

Assume that all appropriate preprocessor directives e.g., `#include <iostream>`, etc. have already been defined.

A. [4 marks]

```
string s = "pineapple pen";
int i = 0, j = s.size() - 1;
while (i < j) {
    s[i] = s[j];
    s[j] = s[i];
    i += 1;
    j -= 1;
}
cout << s << endl;
```

```
nep elple pen
```

B. [4 marks]

```
for (int i = 0; true; i++) {
    cout << i << " ";
    if (i < 7) {
        i += 2;
    } else if (i % 3 == 0) {
        i /= 2;
        continue;
    } else
        break;
}
```

```
0 3 6 9 5 8
```

C. [4 marks]

```
double f(int &x, int y) {
    x /= y;
    cout << x << " ";
    return x;
}

int g(double x, double &y) {
    y /= x;
    cout << y << " ";
    return y;
}

int main() {
    int x = 22;
    double y = 5;
    cout << g(f(x, y), y);
}
```

```
4 1.25 1
```

D. [4 marks]

```
int a[] = {5, 6, 10, 4, 1, 8, -1, 2, 3, 7};
int x = 0;
while (a[x] > 0) {
    x = (x + a[x]) % 10;
    cout << x;
}
```

```
53796
```

Question 2: Airline Baggage [18 marks]

A. A particular budget airline has the following pricing scheme for checked baggage:

Weight	Cost
15 kg	$20
25 kg	$40
40 kg	$90
>40 kg	+$5 per kg

The cost is computed part-thereof, so 17 kg baggage will cost $40. Baggage over 40 kg will cost $90 plus $5 for every excess kg above 40.

[Warm up] Implement the function `int cost(int weight)` that takes as input the weight of the baggage, and returns the cost of the baggage following the pricing scheme above.

[6 marks]

```
int cost(int weight) {
    if (weight <= 15)
        return 20;
    if (weight <= 25)
        return 40;
    if (weight <= 40)
        return 90;
    return 90 + 5 *(weight - 40);

}
```

B. Another airline uses a simpler pricing scheme. It simply charges a fix price of c dollars for every n kg or part thereof. For example, if $c = \$10$ and $n = 5$ kg, then a 17 kg baggage will cost $40.

Implement the function `int cost(int c, int n, int weight)` that takes as input the price, the kg part thereof, and the weight of the baggage, and returns the cost of the baggage.

[6 marks]

```
int cost(int c, int n, int weight) {
    int total = weight / n;
    if (weight % n)
        total += 1;
    return c * total;
}
```

C. Yet another airline has another pricing scheme. It charges \$20 for the first 20 kg, and an extra \$5 for the next 5 kg or part thereof. Subsequently, for every 5 kg, it increases the extra cost by a percentage surcharge.

For example, if the surcharge is 50%, (i.e., 0.5), then after charging \$25 for the first 25 kg, the next 5 kg will cost $\$5 \times 1.5 = \$7.50$. Another 5 kg will cost $\$7.5 \times 1.5 = \$11.25$, ad infinitum.

Implement the function `double cost(double surcharge, int weight)` which takes in the surcharge (as a decimal ratio, e.g. 50% is 0.5) and the weight of the baggage, and returns the cost of the baggage. You should use implement using computation and not use a formula.

[6 marks]

```
double cost(double surcharge, int weight) {
    double cost = 20;
    double stage = 5;
    weight -= 20;
    while (weight > 0) {
        cost += stage;
        weight -= 5;
        stage *= 1+surcharge;
    }
    return cost;
}
```

Question 3: Scrabble [18 marks]

[INSTRUCTIONS] Use of any C++ STL functions is not allowed unless otherwise stated. Functions defined in other parts should be used whenever appropriate.

The game of Scrabble is played using tiles with letters marked on them. Players then attempt to form words on the board using the tiles which they have on hand.

For this question, a set of tiles will be modelled as a C++ vector of char, where each char represents the letter of the tile. You may assume all tiles and letters given are all upper case.

A. The function `int find(vector<char> tiles, char letter)` takes in a set of tiles, and a letter. If the set of tiles contains the letter, `find` returns an index of the vector that matches it. Otherwise, `find` returns -1.

Provide an implementation of the function `find`. [6 marks]

```
int find(vector<char> tiles, char letter) {
   for (int i = 0; i < tiles.size(); i++) {
       if (tiles[i] == letter)
           return i;
   }
   return -1;
}
```

B. When a tile is placed on the board, it will be removed from the player's hand. The function `remove` takes as input a *set of tiles* and a letter. It modifies the input tiles by removing a **single tile** matching the given letter.

Provide an implementation for the function `remove`. You are to decide on the appropriate return type and parameters for the function. [6 marks]

```
void remove(vector<char> &tiles, char letter) {
    int pos = find(tiles, letter);
    for (int i = pos; i < tiles.size()-1; i++) {
        tiles[i] = tiles[i+1];
    }
    tiles.pop_back();
}

// alternatively
void remove(vector<char> &tiles, char letter) {
    tiles.erase(tiles.begin() + find(tiles, letter));
}
```

C. Players needs to know if a particular word can be formed from their set of tiles. The function `bool can_form(vector<char> tiles, string word)` takes a set of tiles and a string as input, and returns `true` if all characters of the word can be *uniquely* matched to the letters in the set of tiles. I.e., duplicate characters in word requires just as many duplicate tiles in the players hand.

For example, if a player has the tiles with letters: `A`, `H`, `O`, `X`, `P`, `Y`, `O` on hand, the word "`HAPPY`" cannot be formed because there is only one `P` in the set of tiles. But the word "`HOOP`" can be formed because there are two `O`'s in the set of tiles.

Provide an implementation for the function `can_form`. [6 marks]

```
bool can_form(vector<char> tiles, string word) {
    for (int i = 0; i < word.size(); i++) {
        int pos = find(tiles, word[i]);
        if (pos == -1) {
            return false;
        }
        remove(tiles, word[i]);
    }
    return true;
}
```

Question 4: Caching, OS & Database [6 marks]

Marks for each part are distributed equally among the sub-parts.

A. Determine which of the following statements are true or false with regards to running several processes on a multi-tasking operating system.

i) Only one process can be executing on a multi-core CPU at any point in time. [T / (F)]

ii) When execution switches to a new process, all data from the old process is cleared from the RAM. [T / (F)]

iii) Different processes can share data and communicate with each other by writing to and reading from the same memory address. [T / (F)]

iv) When a process incurs a page fault, another process might take over to execute on the CPU while the operating system services the page fault. [(T) / F]

[2 marks]

B. Given the following memory block accesses:

```
7, 2, 2, 23, 7, 16, 23, 21, 7, 2
```

Give the **number of cache misses** with the following cache configuration.

i) **Fully Associative** Cache with **four** cache blocks. The **least recently used** block is replaced when necessary. 6

ii) **Direct Map** Cache with **four** cache blocks. Memory blocks in the form $4n+k$ are mapped to cache block k. 8

[2 marks]

Continued on next page

C. Consider the contents of the **`FLIGHT`** table in an SQL database:

Airline	Source	Destination	Plane
BA	BKK	LHR	777
BA	JFK	LHR	777
BA	SIN	LHR	744
KE	ICN	JFK	388
KE	ICN	LAX	77W
KE	LHR	ICN	77W
KE	SIN	ICN	773
SQ	BKK	SIN	773
SQ	FRA	SIN	77W
SQ	JFK	FRA	388
SQ	SFO	ICN	77W
UA	FRA	JFK	744
UA	JFK	LAX	757
UA	LHR	SFO	777

Give the simplest SQL query for each of the corresponding result:

	SQL Query	Result
i)	`SELECT Airline, Plane FROM Flight WHERE Source = 'JFK'`	BA 777 SQ 388 UA 757
ii)	`SELECT * FROM Flight WHERE Source = 'SIN' OR Destination = 'SIN'`	BA SIN LHR 744 KE SIN ICN 773 SQ BKK SIN 773 SQ FRA SIN 77W

[2 marks]

Question 5: 42 and the Meaning of Life [2 marks]

Either: (a) explain how you think some of what you have learnt in TIC1001 will be helpful for you for the rest of your life and/or studies at NUS; or (b) tell us an interesting story about your experience with TIC1001 this semester. [2 marks]

The student will be awarded points as long as he/she is coherent and does not say something obviously wrong.

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— H A P P Y H O L I D A Y S —