NANYANG TECHNOLOGICAL UNIVERSITY

SEMESTER 1 EXAMINATION 2013-2014

CE1007/CZ1007 – DATA STRUCTURES

Nov/Dec 2013 Time Allowed: 2 hours

INSTRUCTIONS

1. This paper contains 4 questions and comprises 5 pages.
2. Answer **ALL** questions.
3. This is a closed-book examination.
4. All questions carry equal marks.

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1. (a) Write a C function `compute()` that takes a 4x4 two-dimensional array `matrix` of floating point numbers as a parameter. The function computes the average of the first three elements of each row of the array and stores it at the last element of the row. For example, the contents of `matrix`, before and after calling the `compute()` function, are given below:

Before `compute()` : 4x4 matrix	After `compute()` : 4x4 matrix
1 2 3 0	1 2 3 2
4 5 6 0	4 5 6 5
7 8 9 0	7 8 9 8
3 4 5 0	3 4 5 4

The function prototype is given as follows:

```
void compute(float matrix[4][4]);
```

(8 marks)

Note: Question No. 1 continues on Page 2

(b) What does the function `f()` do in the following program? State the output of the program.

```
#include <stdio.h>
   int f(char *s1, char *s2);
   int main()
   {
      char a[80] = "abcdefg";
      char b[80] = "ace";
      int n;

      n = f(a,b);
      printf("%d %s", n, a);
      return 0;
   }
   int f(char *s1, char *s2)
   {
      int i=0,j;
      char *s = s1;

      while (*(s2+i) != '\0') {
         for (j=0, s1=s; *s1 != '\0'; s1++)
            if (*s1 != *(s2+i))  s[j++] = *s1;
         s[j] = '\0';
         i++;
      }
      return j;
   }
```

(7 marks)

(c) Write a C program that reads in five words separated by space, finds the first and last words according to ascending alphabetical order, and prints them on the screen. A sample input and output session is given below:

```
Enter 5 words: banana apple orange papaya kiwi
First word = apple, Last word = papaya
```

Note that the user input is underlined. Hint: you may use an array of strings to store the input words for subsequent processing.

(10 marks)

2. (a) What is the output of the following program?

```
#include <stdio.h>
   int main()
   {
      struct s1 {
         char c[4], *s;
      } e1 = {"abc", "123"};
      struct s2 {
         char *p;
         struct s1 ss1;
      } e2 = {"xyz", {"def","456"}};
      printf("%c%c\n", e1.c[0], *e1.s);
      printf("%s%s\n", e1.c, e1.s);
      printf("%s%s\n", e2.p, e2.ss1.s);
      printf("%s%s\n", ++e2.p, ++e2.ss1.s);
      return 0;
   }
```

(7 marks)

(b) Given any positive integer n, the function `fun(n)` is defined based on the following mathematical formulae:

```
fun(n) = 1                 if n = 1
fun(n) = fun(n/2)          if n is even
fun(n) = 2*fun((n-1)/3)    if n>1 and n is odd
```

Write a recursive C function to implement `fun(n)`. The function computes and returns the result. The function prototype is given as follows:

```
int fun(int n);
```

(8 marks)

(c) Write a recursive C function `countZeros()` that counts the number of zeros in a specified positive number num. The function passes the result to the calling function through the parameter `count`. For example, `countZeros(105006)` returns 3 and `countZeros(1357)` returns 0. The function prototype is given as follows:

```
void countZeros(int num, int *count);
```

(10 marks)

3. (a) Explain the importance of the malloc() and free() functions when using dynamic data structures in C.

(6 marks)

(b) State two differences between a linked list and an array.

(4 marks)

(c) Describe an application and a dataset where a linked list is a more suitable data structure than an array.

(6 marks)

(d) Write a function `moveOddItemsToBack()` that accepts an ascending sorted linked list of integers and moves all odd values to the back of the linked list. The odd values should be maintained in ascending sorted order. The function should return the number of odd values that were encountered.

```
int moveOddItemsToBack(LinkedList *ll)
```

If you use any of the LinkedList functions discussed in class, you must explain any impact that they have on the efficiency of your function.

(9 marks)

4. (a) Consider an empty stack of integers. Let the numbers 1, 2, 3, 4, 5, 6 be pushed into the stack in the order they appear from left to right.

Assume S and X indicate the push and pop operations respectively. The operation sequence SSSSSSXXXXXX outputs (pops) the integers in the order: 6, 5, 4, 3, 2, 1.

State an operation sequence that outputs the integers in the following order: 3, 2, 5, 6, 4, 1.

(6 marks)

(b) A queue may be implemented using an array or a linked list. Discuss one advantage and one disadvantage of each implementation.

(8 marks)

Note: Question No. 4 continues on Page 5

(c) Consider a binary tree BT that has 86 nodes. Answer the following questions about BT and explain the reasoning behind all your answers.

(i) What is the minimum height of BT?

(2 marks)

(ii) What is the minimum number of leaf nodes in BT?

(3 marks)

(iii) Suppose BT is also a binary search tree, and has a height of 85. What does that tell us about the items?

(3 marks)

(iv) Explain whether a binary search tree as described in 4(c)(iii) allows for efficient retrieval of the items stored in it.

(3 marks)

END OF PAPER

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Please read the following instructions carefully:

1. **Please do not turn over the question paper until you are told to do so. Disciplinary action may be taken against you if you do so.**

2. You are not allowed to leave the examination hall unless accompanied by an invigilator. You may raise your hand if you need to communicate with the invigilator.

3. Please write your Matriculation Number on the front of the answer book.

4. Please indicate clearly in the answer book (at the appropriate place) if you are continuing the answer to a question elsewhere in the book.