

NANYANG TECHNOLOGICAL UNIVERSITY

SEMESTER 1 EXAMINATION 2012-2013

CE1007/CZ1007 – DATA STRUCTURES

Nov/Dec 2012

Time Allowed: 2 hours

INSTRUCTIONS

1. This paper contains 4 questions and comprises 4 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 `minMax()` that takes a 5x5 two-dimensional array of integers *a* as a parameter. The function returns the minimum and maximum numbers of the array back to the caller through the two parameters *min* and *max* respectively. The function prototype is given below:

```
void minMax(int a[5][5], int *min, int *max);
```

(8 marks)

- (b) Write a recursive C function `sumOddDigits()` that takes a positive integer parameter *n* and returns the sum of the odd digits of the integer to the caller. For example, `sumOddDigits(12345)` returns 9. The prototype of the function is given below:

```
int sumOddDigits(int n);
```

(8 marks)

- (c) Modify your answer in Q1(b) above so that instead of the result being returned directly, it is returned indirectly, via a second parameter.

(5 marks)

Note: Question No. 1 continues on Page 2

- (d) Compare and contrast the two methods of parameter passing used in Q1(b) and Q1(c).

(4 marks)

2. (a) The function `strrchr()` has the following function prototype:

```
char *strrchr(char *s, char ch);
```

This C function locates the last occurrence of *ch* in the string pointed to by *s*. The function returns a pointer to the character, or a null pointer if *ch* does not occur in the string. Write the code for the function without using any of the standard library string functions.

(8 marks)

- (b) You are required to write a program to maintain bank account records. For each bank customer, the following information is required:

- customer name (first_name and last_name, each of at most 10 characters);
- address (at most 80 characters);
- account number (an integer);
- account balance (a real number); and
- account opening date (day, month and year).

- (i) Declare an appropriate structure called *account* to represent a bank account record with the customer information given above.

(5 marks)

- (ii) Write a C program that repeatedly reads in customer data from the user and prints the customer data on the screen until the customer name *End Customer* (i.e., first_name last_name) is read. Your program should include the following two functions: the function `nextCustomer()` reads and returns a record for a single customer to the caller via a parameter *acct*, and the function `printCustomer()` takes a parameter *acct* and then prints the customer information. The prototypes of the two functions are given below:

```
void nextCustomer(struct account *acct);
void printCustomer(struct account acct);
```

(12 marks)

3. (a) Describe what happens when a long-running C program that is continually expanding its data structures does not free unused memory that was dynamically allocated using `malloc()`.

(4 marks)

- (b) A stack may be implemented using an array or a linked list. State one advantage and one disadvantage of each approach.

(6 marks)

- (c) Write a function `copyEvenItems()` that accepts a linked list of integers and returns a new linked list made up of duplicates of only the even-valued items. For example, calling `copyEvenItems()` on the list `[3, 3, 2, 1, 4, 6, 7, 9]` will return a new list `[2, 2, 4, 4, 6, 6]`. You may assume that the input linked list contains only positive numbers. You may also make use of the `get()`, `find()` and `insert()` functions for the `LinkedList` data structure. The prototype of the function is given below:

```
linkedlist * copyEvenItems(linkedlist *l1)
```

(12 marks)

- (d) Describe a situation where storing items in an array is clearly better than storing them in a linked list.

(3 marks)

4. (a) Consider the binary tree **T** in Figure Q4.

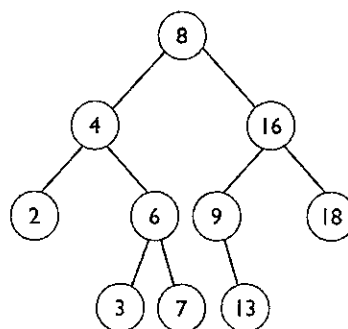


Figure Q4

Note: Question No. 4 continues on Page 4

- (i) Write the order of nodes visited using a pre-order traversal.
(3 marks)
- (ii) Write the order of nodes visited using a post-order traversal.
(3 marks)
- (iii) Is the binary tree T a binary search tree? Explain.
(3 marks)
- (b) Write a recursive C function `sumOddNodes ()` that accepts a pointer to the root node of a binary tree of integers and returns the sum of all odd numbers stored in the tree. The prototype of the function is given below:
- ```
int sumOddNodes(btnode *node);
```
- A btnode structure is defined as follows:
- ```
typedef struct btnode{
    int item;
    struct btnode *left;
    struct btnode *right;
} btnode;
```
- (10 marks)
- (c) If the pre-order and in-order traversal of a binary tree produce the same sequence, what can be said about the structure of the tree?
(6 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.