UNIVERSITY OF GHANA

BACHELOR OF SCIENCE IN ENGINEERING
SECOND SEMESTER EXAMINATIONS: 2014/2015

CPEN 204: DATA STRUCTURES AND ALGORITHMS (3 Credits)

INSTRUCTION: *Answer ALL questions from Sections A and B.*

TIME ALLOWED: *TWO-AND-HALF ($2^1/_2$) HOURS*

SECTION A [20 marks]
Answer all questions in this section

Given the following structure definition and declarations in a C programme, **find error(s), if any, in statements A1-A5 and correct them.**

```
struct Utility
    {
        char companyName[20];
        int year;
        double quantity;
        double consumption;
    };  struct Utility water, electricity;
```

A1. water.quantity=205.2;

A2. water.quantity.consumption=48.3;

A3. electricity.companyName = `GidCo';

A4. strcpy (water.companyName, "ACQUA");

A5. electricity.year = 2014;

Given these structure definition and declarations, **find error(s), if any, in statements A6-A10, and correct them.**

```
struct Xxx
{
    int aa;  double *bb; char *cc[30]
};
struct Yyy
{
    int *dd;  double ee;
}; struct Xxx mm, nn; struct Yyy pp, qq;
```


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A6. mm=pp;

A7. strcpy(nn.cc, "Test");

A8. Xxx.aa = 15;

A9. Yyy.ee = 43.8;

A10. mm=nn;

SECTION B [80 marks]
Answer all questions in this section.

B1. Figure 1 shows a queue of at most 12 elements implemented using array *Q [1...13]* with *head* [Q] =7.

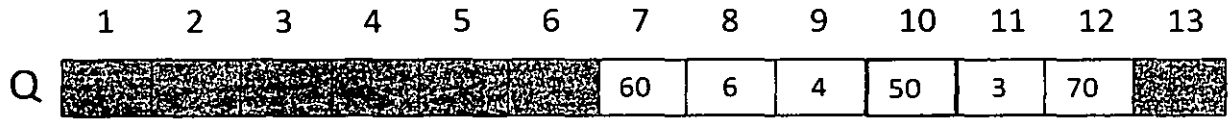

Figure 1

a) Illustrate the configuration of the queue after each of the following operations has been performed successively on it: ENQUEUE (Q, 3), ENQUEUE (Q, 1), ENQUEUE (Q, 4), DEQUEUE (Q), ENQUEUE (Q, 8), and DEQUEUE (Q). **[6 marks]**

b) Find the value of *tail* [Q] after each of the operations in B1.(a) has been performed. **[3 marks]**

c) Using diagrams, show how a **doubly linked list *L*** can be used to represent the dynamic set {1, 4, 9, 16}. **[5 marks]**

d) Show the configuration of ***L*** after performing the following operation: LIST-INSERT (*L*, *x*), where *key[x] =25*. **[2 marks]**

e) Using diagrams describe a *sentinel* and show how this sentinel can turn the *doubly linked list L* in question B1.c) into a *circular, doubly linked list with* a *sentinel.* **[4 marks]**

B2.

a) Explain the concept of *computational complexity* of algorithms. **[3 marks]**

b) Show how *big-O* notation can be used to estimate the following: **[12 marks]**

i. A constant function

ii. A polynomial $f(x) = a_n x^n + a_{n-1} x^{n-1} + \cdot \cdot \cdot + a_1 x + a_0$,

where $a_0, a_1, \ldots, a_{n-1}, a_n$ are real numbers.

iii. The summation of the first N positive integers.

iv. *The factorial of a positive integer N.*

v. *The logarithm of a factorial of a positive integer N.*

vi. *The logarithm of a positive integer N.*

c) Using your estimation in B2. b), derive a *big-O* estimate for $f(n)=3n\log(n!)+(n^2+3)\log(n!)$. **[5 marks]**

B3.

a) Write a C++ programme to implement a ***recursive function*** *recurFact. recurFact* takes as a parameter a positive integer N and returns the *factorial of the positive integer N (N!).* State the *base case* and the *general case* for *recurFact.* **[7 marks]**

b) Write another C++ programme to implement function *iteraFact. iteraFact* takes as a parameter a positive integer N and uses ***iteration*** to calculate and returns the factorial of the positive integer N. **[7 marks]**

c) Analyse the *computational complexity* of each programme in questions B3.a) and B3.b). Which programme is efficient and why? **[6 marks]**

B4.

a) Given the following list A = [1,3,5,7,11,13,17,19,23, 31,33,37], systematically show how each of the following algorithms will locate the element 19 in the list:

i. Linear search **[5 marks]**

ii. Binary search **[5 marks]**

b) Briefly describe the ***divide-and-conquer*** strategy as a problem solving technique. **[4 marks]**

c) Briefly explain the difference between **quicksort** and **merge sort** algorithms. **[6 marks]**