National School of Business Management

Algorithms and Data Structures
CS106.3 - 16.1 Sessional Examination

Time: 03Hrs

Answer all Questions **Date: 29th Mar 2017**

Question 1 – 20 Marks

(a) Briefly explain what an algorithm is in the context of Computing. [5 Marks]

(b) Briefly explain, giving an example, how asymptotic analysis can isolate the algorithm efficiency from the machine and platform dependency. [5 Marks]

(c) Simplify the following Big-O expressions [5 Marks]

i. $O(2n^3+5n-10)$
ii. $O(2n^2+10^2n)+O(n)$
iii. $O(n)*O(log(n))$
iv. $O(n)+O(log(n))$
v. $n*O(1)$

(d) Giving reasons, evaluate the time complexity of the following function. [5 Marks]

```
int fact(int n)
{       if(n==1) return 1;
        return n*fact(n-1);     }
```

Question 2 - 20 Marks

Following code segment implements the binary search algorithm.

```
1     first = 0;
2     last = size -1;
3     found = 0;
4     position = -1;
6     while(!found && first <=last) {
7     middle = (first+last)/2;
8     if(array[middle] == key)  {    found = 1;
9                                    position = middle;    }
10    else if(key<array[middle]) last = middle – 1;
11    else first = middle + 1;
12    }
13    return position;
```

(a) If the above code segment to write inside a function called bsearch() what will be the return type and required arguments for the function? Give your answer by writing the function header including return data type and argument declarations. [5 marks]

(b) Write down a comment line you would include in the above code against each line to illustrate the function of each line or statement. You do not have to copy the code - just put the line number and your comment in your answer script. [5marks]

(c) Copy the following table into your answer script and complete it for each iteration for the problem scenario given below to carry out a desk-check of the code given above.

Variable	initially	After iteration 1	After iteration 2	After iteration 3
key	23			
size	15			
first	0			
last	14			
found	0			
position	-1			
(!found && first <=last)	true			
middle	NA			
array[middle]	NA			

array[]

2	5	9	10	12	15	18	19	23	25	29	30	35	43	45

key =23 [10 Marks]

Question 3 - 20 Marks

The following is a skeleton of a selection sort implementation in C.

```
int minIndex(float d[], int size){      // return the index of
     ...                              // the min in the given array
}
void swap(float *p1, float* p2) {       // swap two vars
     ...
}
void selectionSort(float d[], int size){
     ...
}
```

(a) Write C code to implement the above selection sort algorithm. [10 Marks]

(b) Evaluate step by step, giving reasons, the time complexity of each of the above functions in terms of the Big-O notation. [10 Marks]

Question 4 - 20 Marks

Following code intends to implement a dynamic stack.

```
struct node{   float data;
               struct node* next;  };
struct stack{  struct node* sp;    };

struct node* makenode(float item){  // make a new node with item
...
}
void init(struct stack * s){...}   // initialize sp
int full(struct stack * s){...}         // return 1 if full
int empty(struct stack * s){...}   // return 1 if empty

int push(struct stack *s, float item){  ...
}
float pop(struct stack *s){ ...
}
float top(struct stack *s){...}
```

(a) Write a clear diagram to show the status of the stack structure instance, nodes, stored values and node linking after pushing the values 2.0, 6.2 and 7.0. [6 marks]

(b) Write code for each function above to complete the stack implementation. [14 Marks]

Question 5 - 20 Marks

(a) Draw a binary search tree generated by inserting the following items in the given order.
23, 45, 12, 4, 56, 9, 13, 15, 24, 3 [4 Marks]

(b) Draw the sequence of items you process, if the BST is traversed by,

i. pre-order,

ii. in-order,

iii. post-order, tree walking methods. [6 marks]

(c) Write down a node structure in C, suitable to implement the above BST. [2 marks]

(d) Write a C function to display the above BST in pre-order traversal. [4 Marks]

(e) Write a C function to find a value (key) in the BST by traversing the BST in pre-order manner. [4 Marks]