FINAL EXAM
FIRST SEMESTER SESSION 2011/2012

COURSE CODE / NAME : STIA2023 / DATA STRUCTURES AND ALGORITHM ANALYSIS
DATE : 8TH JANUARY 2012 (SUNDAY)
TIME : 8.30PM – 11:00PM
VENUE : DMS

INSTRUCTION :

1. This book script contains SECTION A for TEN (10) questions, SECTION B for NINE (9) questions, and SECTION C for THREE (3) questions in TWENTY (20) printed pages excluding the cover page.

2. Answer ALL the questions in the space provided.

MATRIC NO : ________________________________ ( with word ) ________________________________ ( with number )

IDENTIFICATION CARD NO. :

LECTURER : ________________________________

GROUP : ___ TABLE NO. : ___

DO NOT OPEN THIS EXAMINATION PAPER UNTIL INSTRUCTED

CONFIDENTIAL
SECTION A: MULTIPLE CHOICE QUESTIONS (10 MARKS)
Instruction: Read ALL questions and use the given answer sheet (on page 5) to mark the best answer.

1. What is the best to answer the question such as “What is the best implementation when the operations deletion and insertion of data are happened rarely?”
   a) I prefer to use static data structure
   b) I will create an object that will refer to the others object from the same classes
   c) I will store it in the nodes
   d) I prefer to save it in the text file

2. Which is a fact when the implementation of inserting first node was implemented but in the same time the list is empty?
   a) Set pointer “link” of new node to the first node
   b) Set pointer “head” to the new node
   c) Set pointer “current” to the first node
   d) Set pointer link of “current” to a new node

3. Select the correct figure that refers to a complete graph.
   a) [Diagram]
   b) [Diagram]
4. Using the following tree, match the order of nodes visited using depth first traversal.

```
  5
 / \
/    \n 4    3 8
 /     /  \
/      /   \
2      7    9
 /          /    /
1          6    10
```

a) 1 2 4 5 6 7 3 10 9 8
b) 5 4 3 8 2 7 9 16 10
c) 1 2 4 6 7 3 10 9 8 5
d) 5 4 2 1 3 7 6 8 9 10
5. Which statement supports the effect of doubling the problem size on an algorithm's time requirement from \(n^2\) to \((2n)^2\)?

   a) The efficiency of effect on time requirement is doubles.
   b) The efficiency of effect on time requirement is no effect.
   c) The efficiency of effect on time requirement is squares.
   d) The efficiency of effect on time requirement is quadruples.

6. Which statement supports the general case in recursion?

   a) In the general case, the solution to the problem is obtained directly.
   b) The general case must eventually be reduced to a base case.
   c) The general case stops the recursion.
   d) Every recursive method must have only one general case.

7. Using the binary search tree below, if we remove the root and replace it with something from the right sub-tree, what will be the value of the new root?

   ![Binary Search Tree Diagram]

   a) 54
   b) 45
   c) 88
   d) 92
8. Using the following tree, what is the order of nodes visited using a post order traversal?

![Tree Diagram]

a) ABCDEFGHIJK
b) GDBHEKIJFCA
c) GDBAHECKIFJ
d) ABDGCEHFJKI

9. What is the best one refer to height balanced?

a) Sub trees of each node have exactly same height
b) Sub trees of each node in the tree differ in height by not more than 1
c) Sub trees of each node in the tree differ in total by not more than 1
d) Height balanced trees are totally not balanced

10. Which statement supports the sequential search?

a) A sequential search is more efficient for large list.
b) A sequential search is much faster than binary search.
c) On average, the sequential search algorithm searches half the list.
d) A sequential search requires the list elements to be in order.
ANSWER SHEET
Instruction: Mark only the best answer for each question.

1. A B C D
2. A B C D
3. A B C D
4. A B C D
5. A B C D
6. A B C D
7. A B C D
8. A B C D
9. A B C D
10. A B C D
1. Show the steps and find the depth first topological ordering of the following graph in alphabet order.

(S marks)
2. This question refers to the segment of codes and the method name called `testMethod()` as defined below. Ignore all syntax errors that may occur.

```java
public int testMethod (int [] values)
{
    int sum = 0;
    for (int i = 0; i < values.length; i++)
        for (int j = 0; j <= i; j++)
            {
                sum++;  
                sum=sum*2;
            
            }
    for (int i = 0; x < values.length; x++)
        for (int y = 0; j < values.length; y++)
            for (int z = 0; z < 4; z++)
                {
                    sum--;  
                    sum=sum/2;
                }
}
```

Assume that `values` has `n` elements.
a. Identify the number of operations required by the `testMethod` method above by filling the empty table below. 

<table>
<thead>
<tr>
<th>Operation</th>
<th><code>testMethod</code> method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignment</td>
<td></td>
</tr>
<tr>
<td>Addition</td>
<td></td>
</tr>
<tr>
<td>Multiplication</td>
<td></td>
</tr>
<tr>
<td>Subtraction</td>
<td></td>
</tr>
<tr>
<td>Division</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL OPERATION</strong></td>
<td>****</td>
</tr>
</tbody>
</table>

(5 marks)

b. What is the running time (Big Oh) of this method? 

(1 mark)

c. If this method takes 5 seconds to complete on an array of 5 elements, calculate approximately how long it takes to run on an array of 100 elements. 

(2 marks)

3. Given the following preorder traversal of arithmetic expression:

```
+ a * / * b c 2 / / ^ a 2 b d
```

Note: The square is representing with symbol `^`

a. Draw an expression tree from the preorder traversal above. 

(5 marks)
b. Create an arithmetic expression equation expression tree from your answer in question 3(a).
   (2 marks)

4. Based on the sequence of letters below:
   \[\text{UNIVERSAL}\]

   a. Draw the Binary Search Tree (BST).
      (4 marks)

   b. Redraw the new BST from your answer in the question 4(a) after deletion of node \(N\).
      (2 marks)
c. Redraw the new BST from your answer in the question 4(b) after addition of node F.

(2 marks)

5. Answer the following questions based on the search keys below.

10, 5, 13, 8, 9, 2, 4, 14

a. Draw the binary search tree that would be produced from the above list of keys.

(2 marks)
b. Show the steps of inserting the keys given into initially empty AVL tree. (8 marks)
(continue answer page for 5(b))
6. This question refers to the array of alphabet order as shown below.

\[
\begin{array}{cccccccccccccccc}
B & F & G & H & I & L & M & N & P & Q & S & U & V & X & Y & Z
\end{array}
\]

a. Solve the searching process using Binary Search technique by showing the steps to search the data of value G in the array above. Identify the current value of first, middle and last index for each step.

(4 marks)

b. How many comparisons involved in this searching?

(1 mark)

c. What is best time efficiency of Binary Search Tree?

(1 mark)
7. Given a list of 10 alphabet characters.

B A G H K M E N I Z

a. Show the steps to sort the numbers in the array by using a Selection Sort (sorting from largest alphabet to smallest alphabet)

(5 marks)

b. How many comparisons and swaps are performed in the sorting?

(1 mark)
8. Show the steps of Heap sort for the following array of elements in ascending order.
(Note: Answer page is divided into 2 columns to save space)

| D | U | B | A | I |

(6 marks)
(continue answer page for 8)
9. Based on the hash function \( H(x) = x \% \text{size of hash table} \), show the steps of inserting the following key into the hash table, namely as hTable by using a quadratic probing technique. Assume that the size of hTable is 13.

5, 7, 10, 18, 31, 44

(9 marks)
SECTION C: PROGRAMMING QUESTIONS (25 MARKS)
Instruction: Answer ALL questions at the provided spaces.

1. This question requires student to write some methods for a class in the linked list. Assume that the first node pointed by head and the last node pointed by last. Currently, the list is empty also head and last pointer are null.

a. Complete THREE (3) constructor methods and it's properties below from class Node. You may not invoke methods from java ADT.

```
class Node
{
    // Data fields for Node
    ____________________________ // data stored in the node
    ____________________________ // link to next node

    // Methods Constructors

    // postcondition: Creates a new empty node.
    public Node() {
        ____________________________
        ____________________________
    }

    // postcondition: Creates a new node storing obj.
    public Node(___________________) {
        ____________________________
        ____________________________
    }

    // postcondition: Creates a new node storing obj
    // and linked to node referenced by next.
    public Node(___________________) {
        ____________________________
        ____________________________
    }
}
```
b. Develop a `removeLastNode()` method that deletes the last node in the linked list. Make sure to appoint current pointer for traversal. You can use the properties in the class `Node` from question 1(a).

(5 marks)

2. Below is a `displayArray` method that displays the element contents of an array. Rewrite this method again that using recursively processing an array technique by divides the array into two halves.

(5 marks)

```java
public void displayArray(int[] numbers)
{
    for (int i = 0; i < numbers.length; i++)
        System.out.println(numbers[i]);
}
```
3. Study the method `findIt()` given below:

```java
public static int findIt(int p, int q) {
    if (q == 0)
        return p;
    else
        return findIt(q, p % q);
}
```

a. What is the values of `findIt(6, 21)` and `findIt(6, 8)`? (2 marks)

b. If `a` and `b` are positive integer, describe the purpose of this recursive method. (2 marks)

c. Rewrite this method again that convert from recursive method to non-recursive method. (3 marks)

END OF QUESTION