



# UNIVERSITI TEKNOLOGI MALAYSIA

SEMESTER I 2015/2016

FINAL EXAM

**CODE OF SUBJECT** : SCSJ2013  
**NAME OF SUBJECT** : Data Structure and Algorithm  
**YEAR / COURSE** : 2SCV, 2SCR, 2SCJ, 2SCI, 2SCD  
**TIME** : (2 Hours and 15 Minutes)  
**DATE** :  
**VENUE** :

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## INSTRUCTIONS TO THE STUDENTS:

This exam book consists of 2 parts:

Part A : 10 Objective Questions 10 marks

Part B : 6 Structured Questions 90 marks

**ANSWER ALL QUESTIONS IN THE EXAM BOOKLET.**

<b>Name</b>	
<b>Identity card (or matric) Number</b>	
<b>Name of Lecturer</b>	
<b>Subject Code and Section</b>	

This examination book consists of 11 printed pages excluding this page.

## PART A – OBJECTIVE QUESTIONS

[ 10 marks]

Part A consists of 10 objective questions. Choose the correct answer, and write your answer in the answer sheet provided. Each question carries 1 mark.

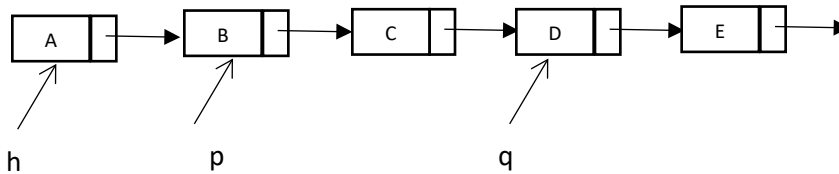
1. If an array consists of 1000 integers, what is the maximum number of comparisons against the target item that might be performed by binary search?
  - A. 1000
  - B. 500
  - C. 10
  - D. 1
  
2. What is the **worst case** runtime complexity of searching for an item in an unsorted array using linear search?
  - A.  $O(\log_2 n)$
  - B.  $O(n)$
  - C.  $O(n^2)$
  - D.  $O(n^3)$
  
3. Suppose that p and q point to adjacent nodes (p before q) in a linked list of nodes defined by class `nodeType`. What is the missing statement so that a new node is inserted between p and q.

```
class nodeType
{ public:
    int info;
    nodeType *next;
}
nodeType *head, *p, *q, *newNode;
newNode = new nodeType;
// Missing statement
p->next = newNode;
```

- A. `q=newNode->next;`
- B. `newNode->next=q;`
- C. `p->next=q;`
- D. `p=newNode->next;`

4. In following linked list what is the output of portion code?

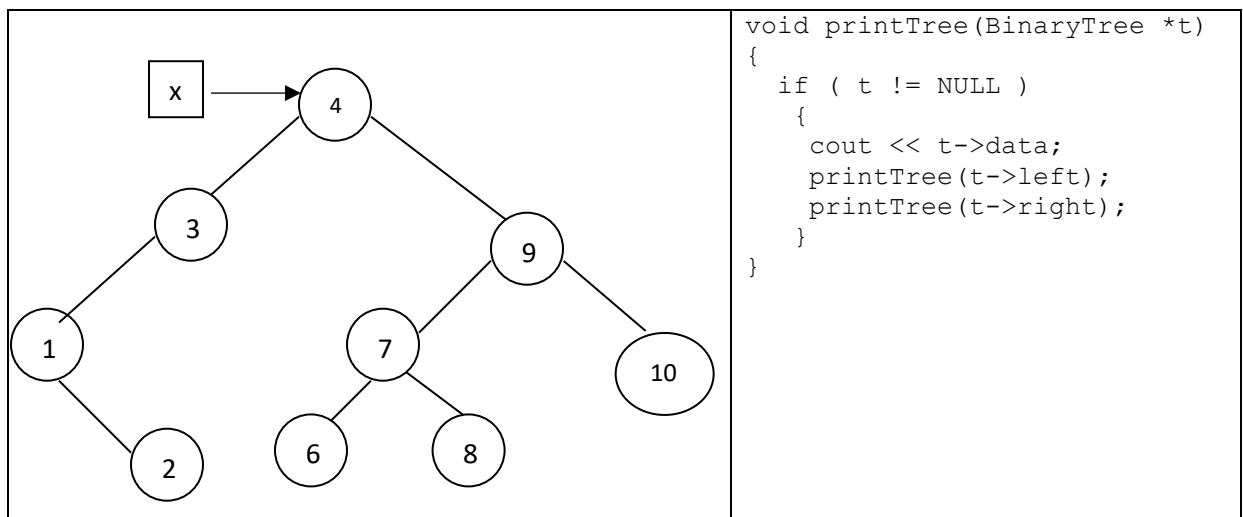
```
struct node {  
    int data;  
    struct node* next; };
```



```
cout << h->next->next->next->data  
cout << p->next->data  
cout << q->data  
cout << p->next->next->data
```

- A. E B C D  
B. E C D D  
C. D C D D  
D. D B D E
5. Which of the following statements are **TRUE** about stack?
- i. A stack is a linear list data structure.
  - ii. The size of stack implemented using array is flexible. An, item can be pushed and popped dynamically.
  - iii. Stack can be implemented using array and linked list.
  - iv. A stack has Last In First Out (LIFO) property.
- A. i, ii, and iv                      C. i, iii, and iv.  
B. i, ii, and iii                     D. All above
6. What will be the initial value of `top` when an array based stack is created ?
- A. 0                                  C. -1  
B. false                             D. true
7. Which of the following scenario is an example of array-based queue?
- A. An Address Resolution Protocol table stores a mapping of IP and MAC addresses, in which least used mapping will be deleted when the table is full.
- B. A mobile node that join a network requests an IP address from an Access Point, but the request will be rejected when all IP addresses have been allocated.

- C. Each network application that runs on a computer will be assigned with next available network application port numbers, ranges between 1024 - 49151.
- D. For online purchase, a system will stamp all requests based on their time of arrival on the server. The system will display the balance of phone stock while “Sold out” message will be displayed when all units are sold to first 500 customers, who successfully checkout of the system.
8. All the following statement are **TRUE** for circular queue using linked-list, **EXCEPT**
- Only one external pointer that point to rear node is required.
  - In the case of an empty list, the value of an external pointer is `NULL`
  - It is possible to have two external pointers that point to front and rear node
  - It is possible for an external pointer to point to itself.
9. Which of the following traversal type would print all node values of binary search tree in **sorted order**?
- Preorder
  - Postorder
  - Inorder
  - None of the above
10. In **Figure A1** below. x is the root of a tree. What is the **OUTPUT** if `printTree(x)` is executed ?



**Figure A1: Binary Search Tree**

- 4 3 1 2 9 7 6 8 10
- 2 1 3 6 8 7 10 9 4
- 1 2 3 4 6 7 8 9 10
- 4 1 3 2 7 9 6 10 8

**PART B – STRUCTURED QUESTIONS****[90 marks]**

Part B consists of 6 structured questions. Answer all questions in the booklet. The marks for each part of the question is as indicated.

**Question 1****[15 marks]**

Answer the following questions based on the sorted array named **Temp** shown in **Figure B1.1**. The array contains temperature values in degree Celsius for one week.

	[0]	[1]	[2]	[3]	[4]	[5]	[6]
<b>Temp</b>	26	29	32	35	39	40	44

**Figure B1.1: Temp array**

- (a) Perform improved linear search using **SortedSeqSearch()** function for searching temperature value = **35**. Show tracing of your search using variables **index**, **p**, **search\_key**, **array[p]**, and **found** as shown in the table format below: [4 marks]

<b>index</b>	<b>p</b>	<b>search_key</b>	<b>Temp[p]</b>	<b>Found</b>

- (b) Perform binary search for searching temperature value = **49**. Show tracing of your search using variables **index**, **LEFT**, **RIGHT**, **MIDDLE**, **search\_key**, **Temp[MIDDLE]**, and **found** as shown in the table format below: [4 marks]

<b>Index</b>	<b>LEFT</b>	<b>RIGHT</b>	<b>MIDDLE</b>	<b>array[MIDDLE]</b>	<b>search_key</b>	<b>found</b>

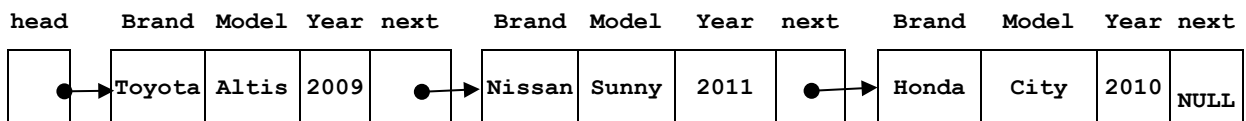
- (c) Fill in the following table with the number of steps and the complexity time for searching **key = 29, 35 and 49**. Based on the results, compare and discuss the efficiency of binary search and linear search (on sorted data) algorithms in the three searching case. [7 marks]

Searching Comparisons				
Search Key	Linear Search		Binary Search	
	Number of Steps	Complexity	Number of Steps	Complexity
Discussion				

## Question 2

[15 marks]

- a) **Figure B2.1** shows a singly linked list that stores the information for cars. Pointer **head** points to the first node in the list.



**Figure B2.1 : Linked-list for Cars**

- i) Write a class definition of a node for the linked-list in Figure 2.1. Every node should have **Brand**, **Model**, **Year** and **next** as the attributes. Also, define a pointer variable called **head** which will point to the first node in the list. [3 marks]
- ii) Write the source codes that will display all the information of the cars as the output shown in **Figure B2.2**. You need to use the pointer **head** in order to print the value.

```

Brand : Toyota
Model : Altis
Year  : 2009

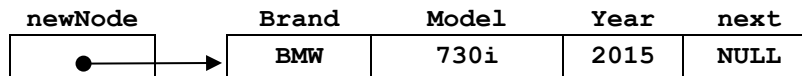
Brand : Nissan
Model : Sunny
Year  : 2011

Brand : Honda
Model : City
Year  : 2010
  
```

**Figure B2.2 : Output**

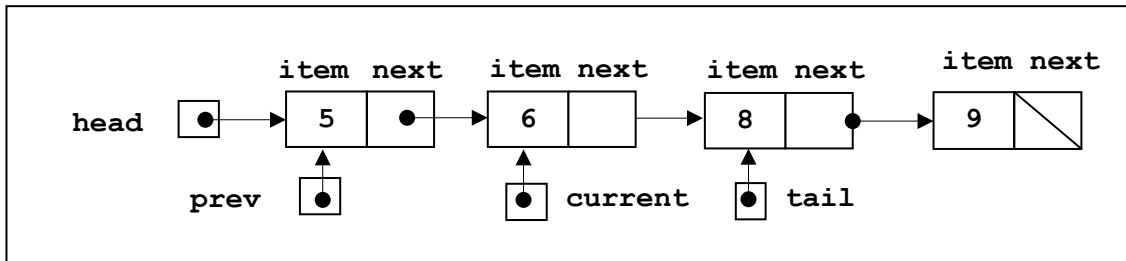
[3 marks]

- iii) Based on your previous class definition in a(i), write the code to create a new node as shown in **Figure B2.3**, and then assign the following data to the new node: "BMW", "730i", 2015.



**Figure B2.3 : newNode** [2 marks]

- b) **Figure B2.4** shows a linked list that has 3 nodes and 4 pointers **head**, **prev**, **current** and **tail**.



**Figure B2.4 : Linked-list with 3 nodes.**

The node with the value of 6 is going to be removed from the list. Write the code will delete the node from the list using pointer **prev** and **current**.

[3 marks]

- c) Given the code segment in **Program B2.1**, answer the following question, i until iv.

```

1  Node *newnode;
2  newnode->item = 2;
3
4  newNode->next = head;
5  head = newNode;
6
7  prev = prev->next;
8  prev->item = 7;
9
10 tail = tail->next;
11 tail->next = head;
  
```

**Program B2.1 : A code segment in a linked-list**

- i) Draw the state of the linked list in **Figure B2.4** after the execution of statement in line 1-2. [1 mark]
- ii) Draw the state of the linked list in **Figure B2.4** after the execution of statement in line 4-5. [1 mark]

iii) Draw the state of the linked list in **Figure B2.4** after the execution of statement in line 7-8.

[1 mark]

iv) Draw the state of the linked list in **Figure B2.4** after the execution of statement in line 10-11.

[1 mark]

### Question 3

[15 marks]

a. Given a declaration of a stack object named `z`, and array `text1[ ]` in **Program B3.1**, answer the following questions:

```
1 //Program_B3.1
2
3 class Stack
4 {
5     private:
6         int top;
7         char text[5];
8     public:
9         void createStack();
10        void push(char newItem);
11        void pop();
12        void getStackTop();
13        bool isEmpty();
14        bool isFull();
15 };
16
17 int main ()
18 {
19     Stack z;
20     char text1[5] ={'m','a','d','a','m'};
21     z.createStack();
22     for (i=0; i<5;i++) {
23         char a = z.push(text1[i]);
24         cout << a << endl ;
25     }
26     cout << " \n " << endl;
27     int n=0;
28     while( !z.isEmpty()) {
29         if ( z.getStackTop() != text1[n] ) break;
30         char b = z.pop();
31         cout << b << endl ;
32         n++;
33     }
34 }
```

**Program B3.1 : Stack Program**



i) What is the output when Program B3.1 is executed? [2 Marks]

ii) What is the output when `text1` in line 20 array is set to :

`char text1[5] = { 'm', 'o', 'd', 'e', 'm' };` [1 Mark]

iii) Describe what Program 1 does based on your answer in (i) and (ii) above. [1 Mark]

b. Convert the following infix expressions to postfix form using the stack algorithm. Show your step using the table format given below: [5 Marks]

Infix expression      `a/b*c-(d+e*f)`

Infix	Stack	Postfix

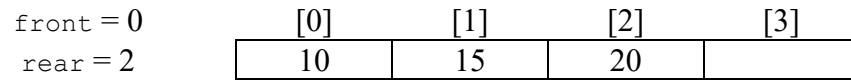
c. Evaluate the following postfix expressions by using the stack algorithm. Assume the following values for the identifiers: `a = 2; b = 3; c=2; d = 5; e = 10`. Show your step using the table format given below: [6 Marks]

Postfix      `e a b c * + - d -`

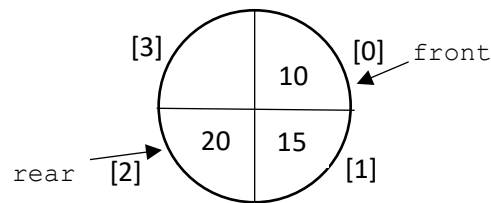
postfix	ch	Opr	Opn1	Opn2	result	stack

**Question 4****[15 Marks]**

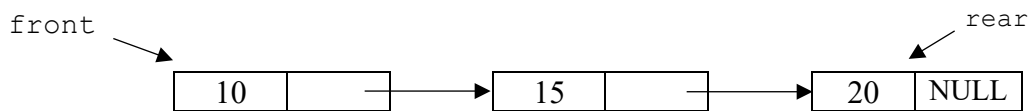
1. **Figures B4** (a), (b), and (c) show initial content of three different implementations of a queue. Assumed maximum size of an array is 4.



(a) Linear-array queue



(b) Queue using circular-array



(c) Singly linked-list queue

**Figure B4:** Three implementations of a queue

- a) Perform the following operations to the three different queues and redraw the queues for each update: [9 Marks]

- i) enqueue (25)
- ii) dequeue ()
- iii) enqueue (30)

- b) Which queue implementation causes problem? At which operation does the problem arise? Name and describe the cause to the problem.

[4 Marks]

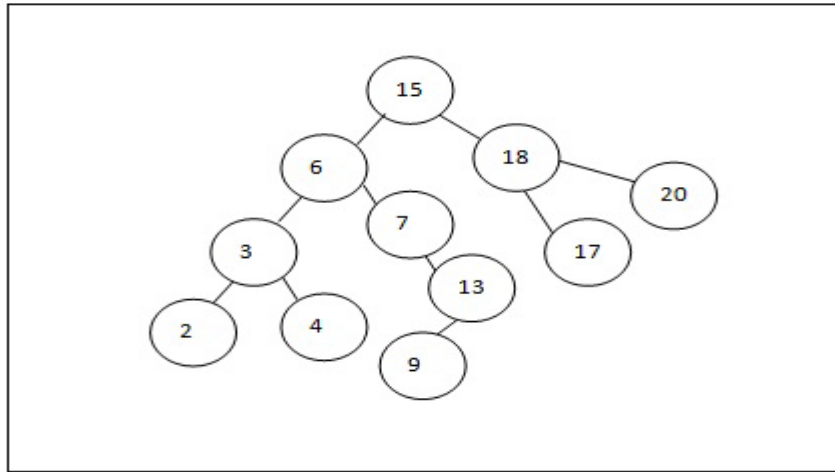
- c) Which implementation is the best? Justify your answer.

[2 Marks]

**Question 5****[ 15 marks]**

The following questions are related to binary tree and BST .

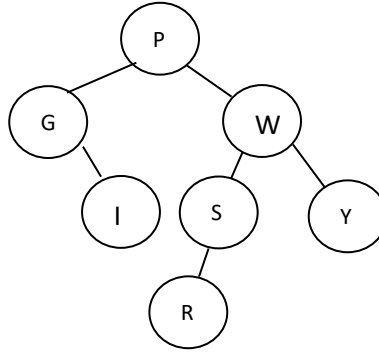
- a) Give the inorder and preorder traversal of the tree in **Figure B5.1**

**[4 Marks]**

**Figure B5.1 : Binary Search Tree of number value**

- i) Inorder traversal : \_\_\_\_\_
- ii) Preorder traversal : \_\_\_\_\_
- b) Draw a binary search tree based on the sequence of number inserted in the following order :  
{57, 85, 35, 9, 47, 20, 26, 99, 93, 10} (starting with 57 and ending with 10). **[4 Marks]**
- c) Based on the tree that has been generated in b) answer the question below **[2 Marks]**
- i) Depth of tree : \_\_\_\_\_
- ii) Depth of node 20 : \_\_\_\_\_
- iii) Level of tree : \_\_\_\_\_
- iv) Height of tree : \_\_\_\_\_
- d) Give the postorder traversal of the tree generated in question (b). **[3 Marks]**

- e) Based on **Figure B5.2**, redraw the tree when the following nodes are deleted in sequence node W [2 Marks]



**Figure B5.2 : Binary Search Tree**

### Question 6

[15 marks]

- a). Given two case studies below, identify the most suitable data structure that can be implemented in each situation. Justify how the data structure can be used efficiently to store information based on the situation.
- i) A supervisor in a factory is required to manage 20 workers under him. The supervisor needs to plan the worker's career path, the detail worker's key performance index (KPI) score and the workers personal problem. Describe how the workers information can be stored efficiently for easy access by the supervisor. Please justify, why you choose the data structure.
- ii) UTM photographic Outlet offer photography service during convocation. The number of UTM graduates who come to their outlet are varies, and also from a different state and countries. Describe how the graduate information can be recorded and stored efficiently in order for the management to have report about their customers and their earnings. Please justify, why you choose the data structure.
- b). Give one situation in which storing data using array is better than using linked list. Describe one case study or problem to represent the situation.

[5 Marks]

[5 Marks]

[5 Marks]