AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Computer and Systems Engineering Department
Third Year Computer Engineering Students

2nd Semester, 2015-2016 **Course Code: CSE323** ***Time : 3.00 Hrs***

Programming with Data Structures

The exam consists of **five** Questions in **three** Pages. ***Total Marks: 110 Marks*** **1/**9

تعليمات هامة

1) حيازة التيلفون المحمول مفتوحا داخل لجنة الأمتحان يعتبر حالة غش تستوجب العقاب وإذا كان ضرورى الدخول بالمحمول فيوضع مغلق فى الحقائب.
2) لا يسمح بدخول سماعة الأذن أو البلوتوث.
3) لايسمح بدخول أي كتب أو ملازم أو أوراق داخل اللجنة والمخالفة تعتبر حالة غش.

Answer all the questions and assume any missing data.

Question 1 [22 marks]

Complete the following sentences:

a) The big O of finding the minimum item of a given heap of n elements is ____
b) Open hashing has two different data structures_____ and _____
c) In the heap, the three functions parent, left and right are used to _____
d) To sort a linked list using merge sort the big O is _____
e) A priority _____ can be used to store requests in an elevator system.
f) In a dictionary application, words are better stored in _____ data structure.
g) To check the balance of XML tags a _____ is usually used.
h) The maximum element in a binary search tree is found in_____
i) To add one element to the heap, the big O of this operation is _____
j) Heap sort is better than quick sort because _____
k) The minimum number of edges in a connected undirected graph of n nodes is _

Question 2 [22 marks]

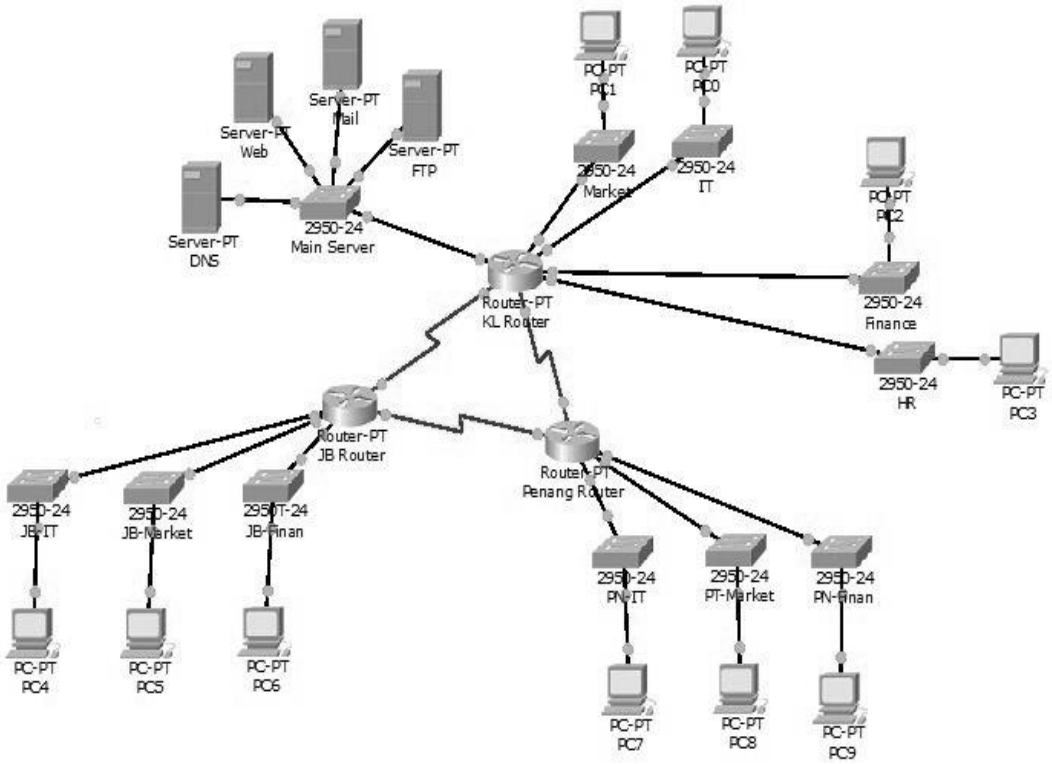
Consider the following list of students data with the ids: p07112, p07220, p07119, p07120, p07302, p07250, p07400, p07363, p07006, p07301.

a) It is required to heapify them (put them in a heap and show the heap as it is growing step by step) **[5 marks]**
b) Add the students ids in the given sequence to a binary search tree (show the tree after adding all of them) **[5 marks]**
c) Traverse the binary search tree built in part b using in-order traverse **[4 marks]**
d) Find average search time to look for each item found in the BST **[4 marks]**

e) If the order of the students are different would the heap and binary search tree differ from those created in part a or b **[4 marks]**

Question 3 [22 marks]

Assume the following graph about computer network routers: (Note: You do not need to have any information from the labels of the following graph)



a) Start from any router (the three central nodes) use depth first traverse to provide ids 1, 2, 3, etc Replace each node with a circle containing the id value (feel free to choose which node to go first among its sister nodes) **[8 marks]**

b) How many spanning trees could be resulted from this graph? **[2 marks]** Draw any one of them. **[6 marks]**

c) If the whole adjacency information is stored in routers (the three central nodes) show the data structured needed to be stored in any of them **[6 marks]**

Question 4 [22 marks]

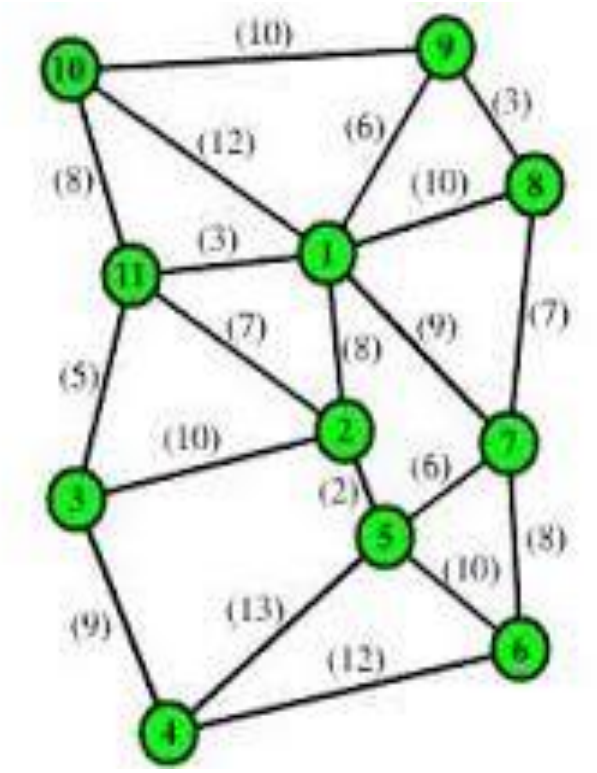
a) Write an algorithm that takes a tree of text information representing (outline) and sets the nodes to ids like1,1.1,1.3,1.3, 1.1.1 .. based on their depth/levels and are they to the left or right within their parent node. The root node has id 1 and its children 1.1, 1.2 etc. **[7 Marks]**

b) Compare between closed and open hashing from the following aspects: easy to develop, access time, number of expected collision. **[8 Marks]**

c) Design a hashing system (including hashing function, primary and secondary data structure if needed) to take student first names and create an index to quickly access students data. **[7 Marks]**

Question 5 [22 marks]

The following graph is a sensor network. Assume each node has an id and data. Copy the following graph to your answer sheet then answer the following questions:



a) Write an algorithm that takes such a sensor network graph and it finds the id of the node with maximum node data. Assume starting from any node and all sensor nodes are reachable. **[6 marks]**

b) Find a MST using Kruskal algorithm starting from node 5 draw the MST and compute its cost. **[8 marks]**

c) Find the shortest path between node 11 and node 6, using Dijkstra algorithm**. [8 marks]**

Good Luck

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Model Answer

Question 1 [22 marks]

Complete the following sentences:

l) The big O of finding the minimum item of a given heap of n elements is **O(n)**
m) Open hashing has two different data structures **primary DS array and secondary DS linked list or BS trees**
n) In the heap, the three functions parent, left and right are used to **traverse the tree upwards and downwards**
o) To sort a linked list using merge sort the big O is **O(n log n)**
p) A priority **queue** can be used to store requests in an elevator system.
q) In a dictionary application, words are better stored in **hash** data structure.
r) To check the balance of XML tags a **stack** is usually used.
s) The maximum element in a binary search tree is found in **right most**
t) To add one element to the heap, the big O of this operation is **O(log(n))**
u) Heap sort is better than quick sort because guarantees **n log (n)** heap is awlays balanced and left justified
v) The minimum number of edges in a connected undirected graph of n nodes is **(n-1)**

Question 2 [22 marks]

Consider the following list of students data with the ids: p07112, p07220, p07119, p07120, p07302, p07250, p07400, p07363, p07006, p07301.

f) It is required to heapify them (put them in a heap and show the heap as it is growing step by step) **[5 marks]**

112
112,220→ 220,112
220,112,119
220,112,119,120→ 220,120,119,112

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g) Add the students ids in the given sequence to a binary search tree (show the tree after adding all of them) **[5 marks]**

h) Traverse the binary search tree built in part b using in-order traverse **[4 marks]**
The numbers of the students will printed out in correct order as they are sorted

i) Find average search time to look for each item found in the BST **[4 marks]**
Need to add the depth of each node together and divide it over the number of nodes

j) If the order of the students are different would the heap and binary search tree differ from those created in part a or b **[4 marks]**
Heap will have the same structure but different data order for the binary tree will be different

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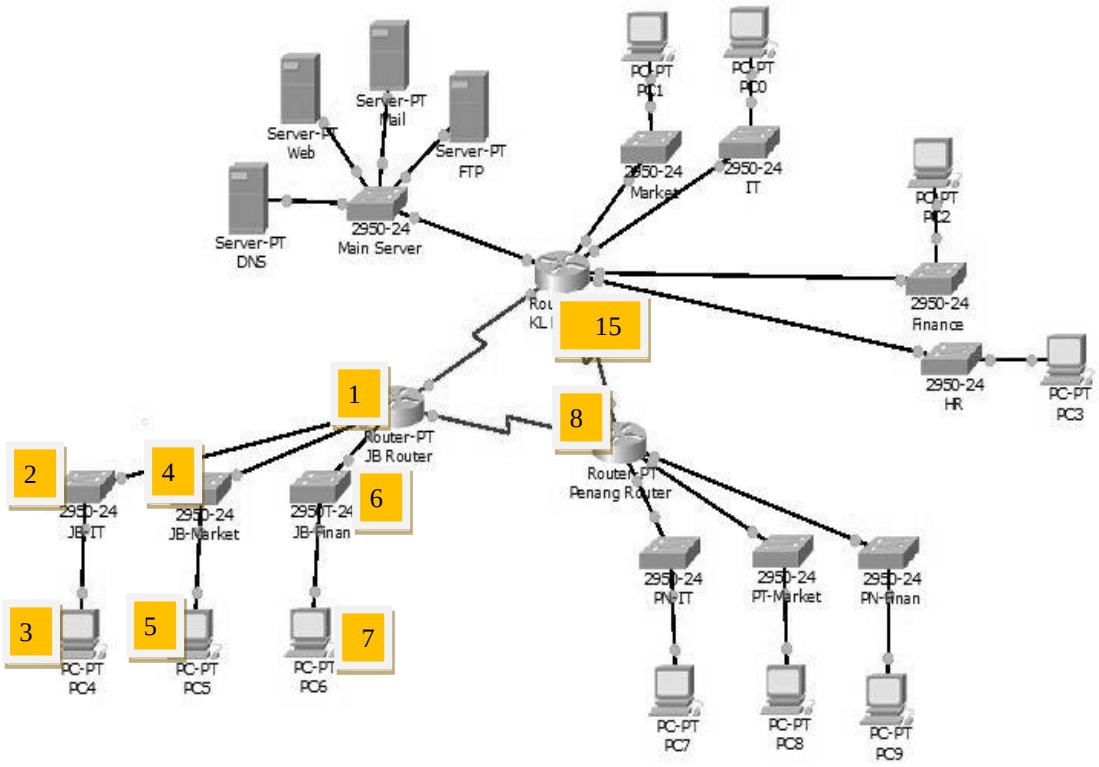
Question 3 [22 marks]

Assume the following graph about computer network routers: (Note: You do not need to have any information from the labels of the following graph)



d) Start from any router (the three central nodes) use depth first traverse to provide ids 1, 2, 3, etc Replace each node with a circle containing the id value (feel free to choose which node to go first among its sister nodes) **[8 marks]**
Numbers indicating are attached to the figure

e) How many spanning trees could be resulted from this graph? **[2 marks]** Draw any one of them. **[6 marks]**
3 spanning trees disconnect any two routers of the given three

f) If the whole adjacency information is stored in routers (the three central nodes) show the data structured needed to be stored in any of them **[6 marks]**
Either matrix or linked list format
But could be distributed tables so information in each router tell what pc and switched are connecting there
Example for router 1 matrix will be

	1	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***15***
1		☑		☑		☑		☑	☑
2	☑		☑						

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3		☑							
4	☑				☑				
5				☑					
6	☑						☑		
7						☑			
8	☑								☑
15	☑							☑	

Question 4 [22 marks]

d) Write an algorithm that takes a tree of text information representing (outline) and sets the nodes to ids like1,1.1,1.3,1.3, 1.1.1 .. based on their depth/levels and are they to the left or right within their parent node. The root node has id 1 and its children 1.1, 1.2 etc. **[7 Marks]**

The algorithm should propage the id of each node from its parent
In each parent node a loop will be executed to dispatch ids for the children using the parent name as prefix followed by the child id as postfix

e) Compare between closed and open hashing from the following aspects: easy to develop, access time, number of expected collision. **[8 Marks]**

The use of "closed" vs. "open" reflects whether or not we are locked in to using a certain position or data structure (this is an extremely vague description, but hopefully the rest helps).

For instance, the "open" in "open addressing" tells us the index (aka. address) at which an object will be stored in the hash table is not completely determined by its hash code. Instead, the index may vary depending on what's already in the hash table.

The "closed" in "closed hashing" refers to the fact that we never leave the hash table; every object is stored directly at an index in the hash table's internal array. Note that this is only possible by using some sort of open addressing strategy. This explains why "closed hashing" and "open addressing" are synonyms.

Contrast this with open hashing - in this strategy, none of the objects are actually stored in the hash table's array; instead once an object is hashed, it is stored in a list which is separate from the hash table's internal array. "open" refers to the freedom we get by leaving the hash table, and using a separate list. By the way, "separate list" hints at why open hashing is also known as "separate chaining".

In short, "closed" always refers to some sort of strict guarantee, like when we guarantee that objects are always stored directly within the hash table (closed hashing).

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Then, the opposite of "closed" is "open", so if you don't have such guarantees, the strategy is considered "open".

f) Design a hashing system (including hashing function, primary and secondary data structure if needed) to take student first names and create an index to quickly access students data. **[7 Marks]**
Student name will be used in a text hashing function that take a string and return a number

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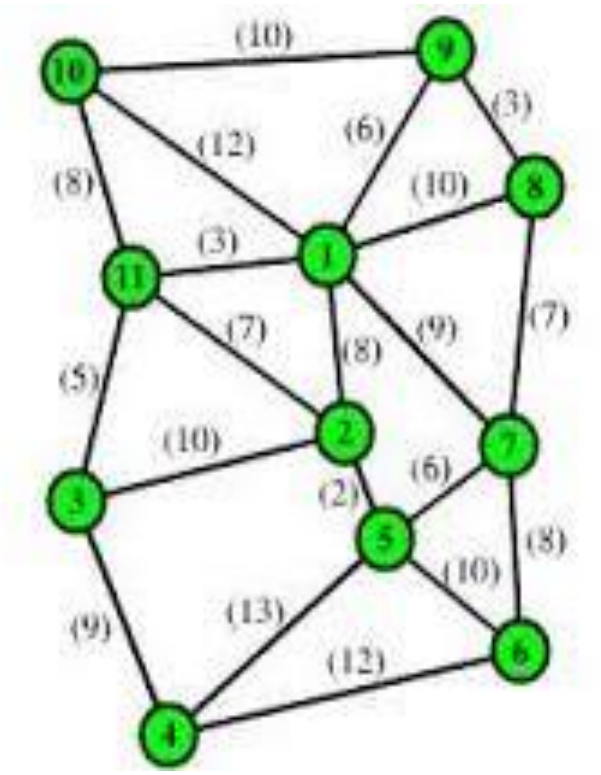
Question 5 [22 marks]

The following graph is a sensor network. Assume each node has an id and data. Copy the following graph to your answer sheet then answer the following questions:



d) Write an algorithm that takes such a sensor network graph and it finds the id of the node with maximum node data. Assume starting from any node and all sensor nodes are reachable. **[6 marks]**

e) Find a MST using Kruskal algorithm starting from node 5 draw the MST and compute its cost. **[8 marks]**

f) Find the shortest path between node 11 and node 6, using Dijkstra algorithm**. [8 marks]**

Good Luck

Ain Shams University, Faculty of Engineering
Programming with the Data structures CSE323 spring 2016

Intended learning outcomes of course (ILOs)

a. Knowledge and understanding

a1 - Describe the process of computer programming.
a2 - Explain object oriented concepts.
a3 - Explain the software engineering process to develop C/C++ programs.
a4 - Outline software testing concepts.

b. Intellectual skills

b1 - Define the engineering problems.
b2 - Derive different solution alternatives for the engineering problems.
b3 - Analyze and compare different methods used in system modeling.
b4 - Demonstrate the role of IDE tools in Computer Programming.

c. Professional and practical skills

c1 - Use of a variety of diagram types flowcharts, class models for the design process
c2 - Develop practical projects using complete analysis, design and implementation

d. General and transferable skills

d1 - Analyze systems based on extensive use cases
d2 - Perform work in a team.
d3 - Use Internet for research

Final Exam Questions/ILO Matrix

	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	D1	D2	D3
Q1	●	●	●	●	●	●	●	●	●	●	●		
Q2				●	●		●		●				
Q3	●	●			●	●	●	●		●			
Q4	●		●	●	●	●	●	●	●	●	●		
Q5		●		●		●	●	●					
Q6	●		●	●				●	●	●	●		

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