Booklet no:__________

I.D no.:______________

M.Sc. Qualification exam - 2011

Date: 01.04.11
Time: 3 hours
Answer **4 out of 6 questions**

Important: In the following table, circle the numbers of the four questions you chose to answer

Question	Grade
1	/25
2	/25
3	/25
4	/25
5	/25
6	/25

Question 1: Data structures

1. Given an array of *n* elements with at most log(n) different values. Suggest an efficient method to sort the array.
    - **a.** Give a description of the algorithm and the data structure used.
    - **b.** Analyze the worst case as well as the best case complexity of your algorithm.
    - **c.** Can you improve your algorithm if the elements are known to be integers bounded by 2n? If so, explain how and if not explain why.

Question 2: Computability and Complexity

Note: you need to prove your answers.

a. Consider the language

$$L_1 = \{<M> \mid \text{M is a TM and } \forall w \in \Sigma^* \text{ if M accepts } w \text{ then M does not accept Rev}(w)\}$$

where $\mathrm{Rev}(w_1 w_2 \dots w_n) = w_n w_{n-1} \dots w_1$. Is $L_1 \in R$? Define $\overline{L_1}$. Is $\overline{L_1} \in RE$?

b. Consider the language

$L_2 = \{<M> \mid$ M is a TM that accepts at least one word that ends with a 0, and rejects at least one word that starts with a 1$\}$

Is $L_2 \in R$? Is $L_2 \in RE$?

Question 3: Computer Networks

Consider a TCP Reno connection with an initial threshold of 32. (TCP Reno is the newer protocol.) Assume that there is a triple duplicate ACK during the 5th and 21nd transmission rounds and a timeout event during the 14th and 18th and 28th transmission rounds. (In each round the sender transmits all the segments in its congestion window and either receives acknowledgements for them or there is a loss event during the round.

What are the values of the congestion window size, and of Threshold during the first 30 transmission rounds? Fill in the values in the table below.

Transmittion round	**Congestion window size (in segments) at the beginning of the round**	**Threshold value at the beginning of the round**
1	1	32
2		
3		
4		
5 triple-ack		
6		
7		
8		
9		
10		
11		
12		
13		
14 timeout		
15		
16		
17		
18 timeout		
19		
20		
21 triple-ack		
22		
23		
24		
25		
26		
27		
28 timeout		
29		
30		

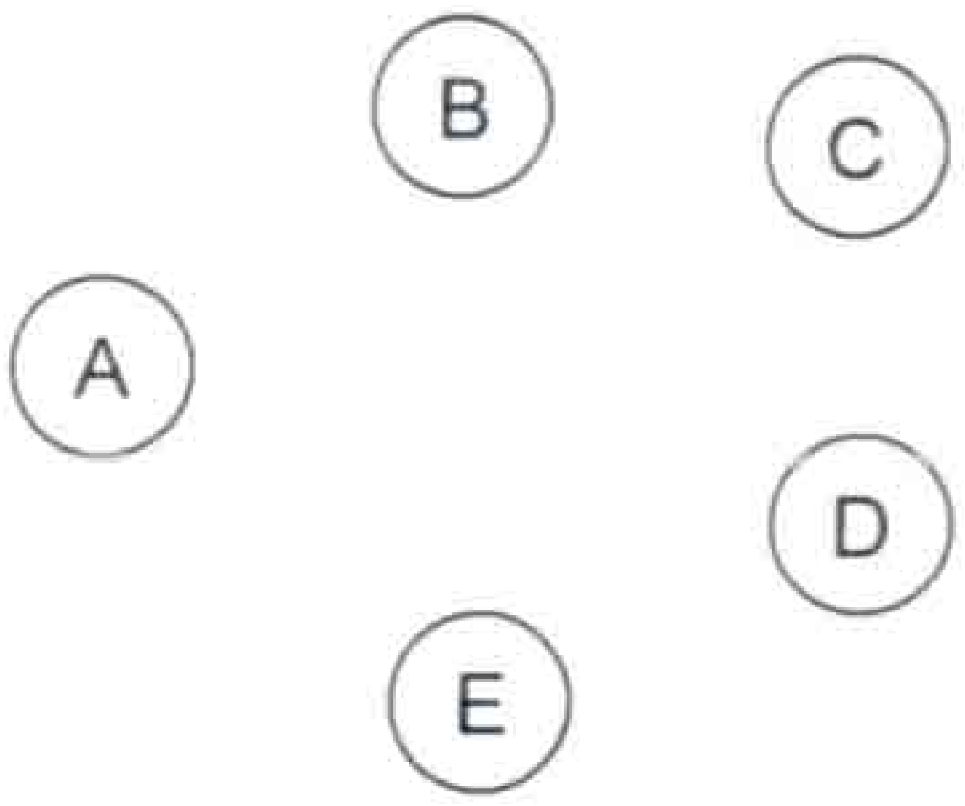
Question 4: Algorithms

1. Given is a network flow N=(V,E) in which the capacities of all edges are even integers, except for one edge e that has an odd capacity. Let f be a max-flow in the network. It is known that the value of f is odd. Prove of give a counter example: the edge e is saturated in the flow f, that is, f(e)=c(e).

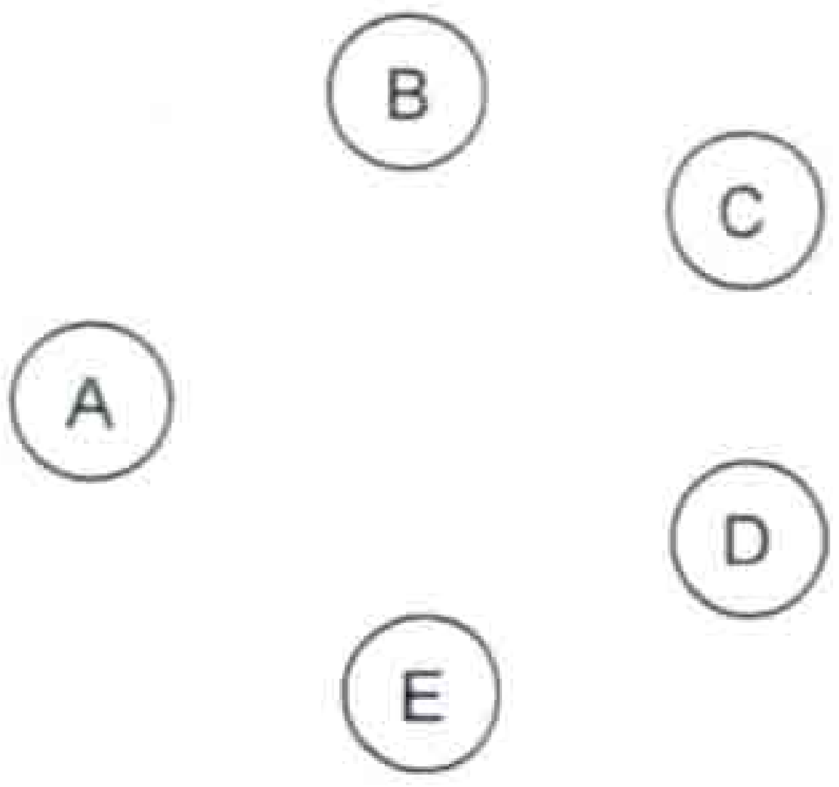
2. Prove that there is at least one leaf (a vertex with degree 1) in any undirected tree.

3. Complete the figure (draw in the form or copy the whole graph to your exam notebook) such that the resulting **undirected** graph over V={A,B,C,D,E} fulfills **all** the following conditions:

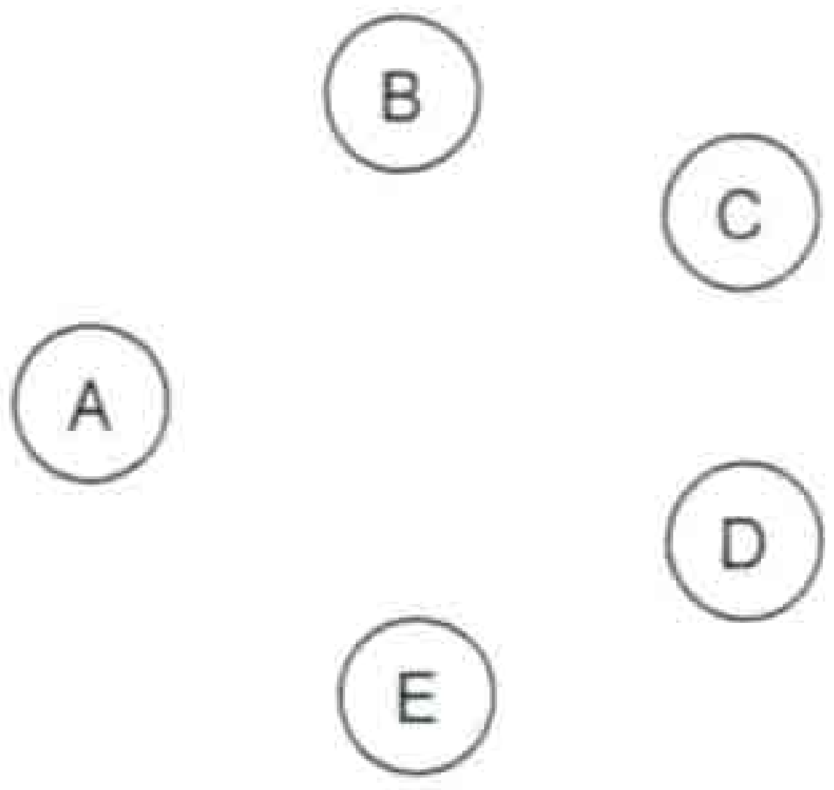
   a. In every run of DFS(C), in the resulting directed tree, it holds that out-degree(C)=2.
   b. G has a Hamiltonian path but not a Hamiltonian cycle.
   c. In every run of BFS(E) it holds that label(D)=3 .



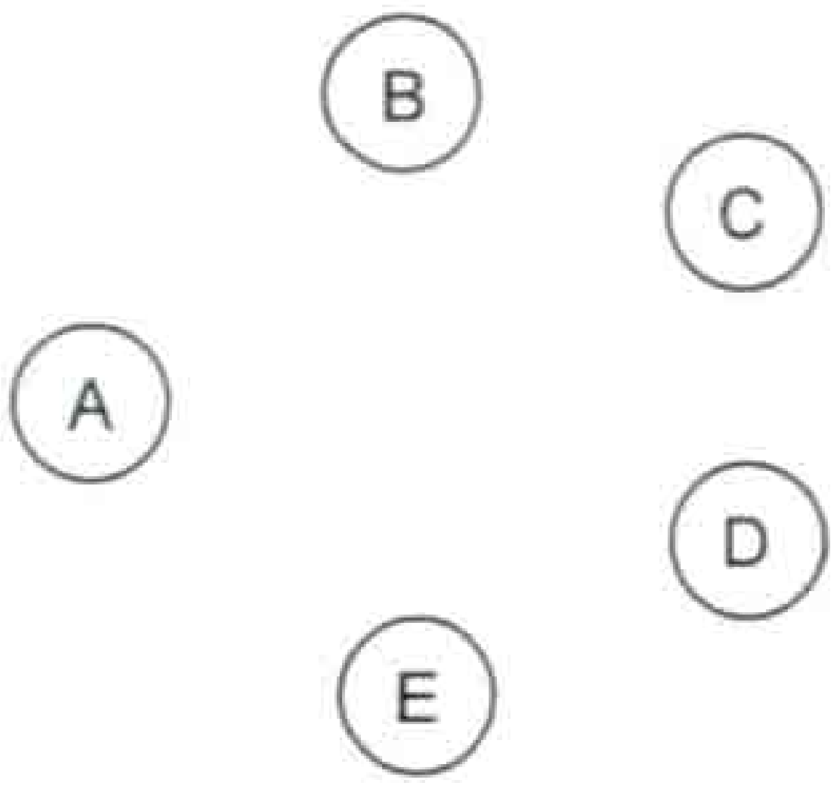
Describe a possible DFS tree corresponding to condition 1 (direct the edges from parent to children)



Describe a Hamiltonian path corresponding to condition 2



Describe a possible BFS tree corresponding to condition 3 (direct the edges from parent to children).



Question 5: Automata and Formal Languages

a. Fill in the following table

Claim	Correct	Wrong
If a language L can be recognized by a non-deterministic finite automata, L can be recognized as well by a deterministic finite automata.		
If a language L satisfies the pumping lemma for context-free languages, then L can be recognized by a pushdown automata.		
Any finite language is context free.		
The language $\{0^n1^n0^{2n} \mid n>0\}$ is context free.		

b. Given that L is a regular language. **Prove or disprove**: L^* is a regular language as well.

Question 6: Operating System

For each of the following code segments, answer and explain:

A. What is the expected output?

B. How many threads are being created in the program? (Except for the initial thread)

Code I:

```
void main() {
   int i;
   for (i = 0; i < 5; i++)
      createThread(,,printSomething, ...);
}

void *printSomething() {
   int k = 0; // local variable
   while (k < 5) {
      k++;
      printf("%d\n", k);
   }
}
```

Output:

____

____

____

Number of threads created:

____

____

____

Code II:

```
int x; // global variable
void main() {
   createThread(,,doSomething,…);
   createThread(,,doSomething,…);
   join_all_threads(); // assume this command waits for all threads to finish
   printf("%d\n", x);
}
void *doSomething() {
   for (int i = 1 to 3) {
      x++;
   }
}
```

Output:

Number of threads created:

GOOD LUCK

יא

שם המרצה: מרזיב סגל

טופס נלווה לבודק הבחינות

סמסטר 2

שם הקורס בחינת הכשר M.sc **מועד** א' **מסלול** 11235420

מס קורס 3542

תאריך הבחינה 1.4.11

שם הבודק טוקי **מס' המחברות המצורף:** 33

המועד בו הבחינות מוכנות למסירה (לכל המאוחר יומיים ממועד קיום הבחינה) 3.4.11

תאריך לקיחת הבחינה לבדיקה 4.4.11 (נלקח עלידי אסתי)

מועד אחרון להחזרת הציונים 12.4.11 **(נספר מהמועד בו הבחינות מוכנות למסירה)**

1. בחינות בדוקות מוחזרות **למנהל הסטודנטים** במרכז הבינתחומי.
2. את הציונים הקפד לרשום על גבי רשימת תעודות הזהות המופיעה באתר האינטרנט.
להלן קישור להוצאת רשימות סטודנטים:

https://www.idc.ac.il/ExamsDepartment/Examiners/

3. <u>ציון הבחינה יחושב מתוך 100% גם אם הרכב הציון בקורס קובע כי למבחן משקל שונה ממאה אחוז.</u>

4. **<u>אין להוריד ציון בשל שגיאות כתיב.</u>**

הערות : ______________________________

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הריני לאשר כי נלקחו על-ידי לבדיקה ______ **בחינות.**

שם פרטי ______________ **שם משפחה** ______________

ת.ז. ______________ **חתימה** ______________

מס' טלפון ______________

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