**Fall 2017**

**SABANCI UNIVERSITY**
**Faculty of Engineering and Natural Sciences**
**CS 302 Automata Theory**

# *Final Examination*

## *Closed (Book+Notes+All Electronic Devices)*

## *Duration : 150 minutes*

| | |
|---|---|
| ***Q1*** | |
| ***Q2*** | |
| ***Q3*** | |
| ***Q4*** | |
| ***Total*** | |

## **Question 1** (*25* points)

***(a)*** *(8 pts)* State the full definition of a ***nondeterministic finite automaton*** *(NFA)*, ***A = (Q, Σ, δ , s, F)*** including the *extended transition function* ***δE*** and the condition for a string ***u∈Σ**** to be accepted by ***A*** *(in your definition the domain and range of the transition functions* ***δ*** *and* ***δE*** *should be explicitly and clearly specified)*.

***(b)*** *(5pts)* Construct an *NFA* ***A*** with at most ***3*** states that accepts the *regular expression* ***E = (1+0)*.1.(1+0)*** interpreted as a language.

***(c)*** *(6 pts)* Construct a *DFA* ***B*** that accepts the language ***E*** in part ***(b)***.

***(d)*** *(6 pts)* Construct a *minimal state DFA* ***C*** that accepts the language ***E*** in part ***(b)***.

## **Question 2** (*25* points)

***(a)*** *(9 pts)* Specify, clearly and with all the details, a *context-free grammar (CFG)*, ***G = (V, T, R, S)*** that generates the set of *all* ***regular expressions*** over some finite set $\Sigma$.

***(b)*** *(8 pts)* Write down a regular expression ***E*** over the set ***{0,1}*** corresponding to the language ***L*** where for each string ***u*** in ***L*** , ***010*** OR ***101*** is *substring* of ***u***.

***(c)*** *(8 pts)* Sketch an ***NFA*** that accepts the language ***L*** in part ***(b)*** above .

## **Question 3** (*25 points)*

***(a)*** *(7 pts)* State clearly the *definition* of a *PDA* ***P*** accepting a language ***L*** by *final state* ***(L(P))*** ; and by *empty stack* ***(N(P))*** .

***(b)*** *(10 pts)* Compute a *PDA* ***P*** that accepts the language

$L = (\omega \in (0+1)^* \mid \#1\text{s} = \#0\text{s } in\ \omega)$

***(c)*** *(8 pts)* Is your ***PDA*** a deterministic ***PDA (DPDA)*** ? If not try to modify it so that it is a ***DPDA***.

**Question 4** (*25* points)

Consider the language $L = (\omega \in \{a,b,c\}^* \mid \omega = a^{k+1}b^k c^{k-1} \; ; \; k > 0)$

***(a)*** *(15 pts)* Choosing a appropriate $\omega \in L$ *( if you do not show explicitly your choice of* $\omega$ *you get NO credit ! )* and using the *pumping lemma* show that $L$ is NOT a *context-free language*.

***(b)*** *(10 pts)* Compute a ***2***-tape *NDTM* TM $M$ that decides $L = (\omega \in \Sigma \mid \omega = uvu \; , \; u,v \in \Sigma^*, \; u \neq e)$