Fall 2019

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)*(6 pts)* Construct an *ε-NFA* ***X*** with not more than ***5*** states that accepts the language corresponding to the regular expression ***E = ((0.1)*+1***)*. Carefully specify the initial and the final states of ***X***.

(b)*(6 pts)* Construct an *NFA* ***Y*** *(**without** ε-transitions and with the **same states** as those of **X**)* that is equivalent to ***X***. Carefully specify the initial state(s) and the final state(s) of ***Y***

(c)*(7 pts)* Compute a *DFA* ***Z*** that is equivalent to ***Y***.

(d)*(6 pts)* Compute a minimal state DFA ***W*** that is equivalent to ***Z*** . Try to express the language symbolized by ***E*** in a simple *natural language*.

Question 2 (*25* points)

(a)*(13 pts)* Consider the *CFG,* $G = (V,T,R,S)$ where

$V = \{Zero, One, S\}$, $T = \{0,1\}$ and R is given by the following productions:

$S \rightarrow 0\ Zero\ S \mid 1\ One\ S \mid e$

$Zero \rightarrow 0\ Zero\ Zero \mid 1$

$One \rightarrow 1\ One\ One \mid 0$

First write down a leftmost derivation for the string 011010 generated by G and then state the language L_G generated by the grammar *CFG*, G above.

(b)*(12 pts)* Construct a *PDA* $P = (Q, \Sigma, \Gamma, \delta, q_0, Z_0, F)$ that accepts the language :

$L = (\omega \in \{0,1\}^* \mid \omega = 0^n 1^{n+1}, n \geq 0)$ by final state. Is your *PDA* deterministic (a ***DPDA***)? If not convert it to a *DPDA*.

Question 3 (*25 points)*

(a) *(7 pts)* State the definitions of *(i) Chomsky Normal Form,* and *(ii) Greibach Normal Form* for a Context Free Grammar ***G(V,T,R,S)***.

(b) *(8pts)* Consider the *CFG****, G=({X,S}, {a,b,c}, R, S)*** where ***R*** is composed of the following productions :

$S \rightarrow aSc \mid X \mid e$

$X \rightarrow aXb \mid e$

First compute a leftmost derivation for the string a^3bc^2 generated by ***G*** and, in general, state the language L_G generated by ***G.***

(c) *(10 pts)* Compute the *Chomsky Normal Form* for ***G***.

Question 4 (*25* points)

Given a *TM* ***M*** with the tabular description below**,** initial configuration of ***M is (s, # w)*** *and* ***LeftShift*** is a *TM* defined by ***(s, z # w #) |-- $_{LeftShift}$ * (h, z w #)*** where ***z*** and ***w*** are arbitrary strings and ***w*** has no #**'**s (*blanks*) in it.

Label TM	***Condition***	***TM***
>A= R	$\sigma \neq$ #	***\$. $R_{\#}$. $R_{\#}$. σ. $L_{\$}$. σ. A***
	$\sigma =$ #	***$R_{\#}$. LeftShift . $L_{\#}$. h***

(a) *(15 pts)* For the *TM* ***M*** above**,** compute ***step-by-step ,*** relative to the *basic TM*s used in the table, the tape configurations starting with the initial configuration ***(s, # ab)*** where ***a*** and ***b*** are *single events* of the string ***ab*** of length 2.

(b) *(10 pts)* Compute the final ***halted*** configuration corresponding to the *general* initial configuration ***(s, # w)*** where ***w*** is any input string with no #'s in it.