Fall 2020

18.1.2021

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

Remote Final Examination

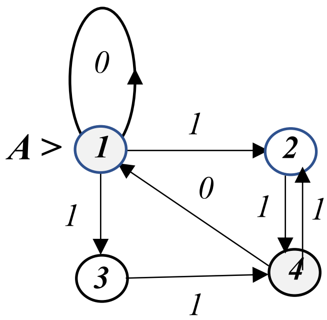
Closed (Book+Notes+All Electronic Devices)

Duration: 180 minutes

Question 1 (*25* points)

(a) *(5 pts) State the full definition of a* ***Nondeterministic Finite Automaton*** *(NFA) ; in particular the* ***domain*** *and* ***range*** *of the transition function* $\boldsymbol{\delta}$ *and the extended transition function* $\boldsymbol{\delta E}$ *and the condition for an NFA to accept a string* $\boldsymbol{u \in \Sigma^*}$ *in terms of* $\boldsymbol{\delta E}$ *and the set of final states* ***F.***

(b) *(3 pts) State whether the NFA* ***A*** *below is a DFA with your reasons.* ***1*** *and* ***4*** *are the final states.*



(c) *(12 pts) Compute a* ***minimal state*** *DFA* ***C*** *that is equivalent to the NFA* ***A*** *in part* ***(b).***

(d) *(5 pts) Try to express the language accepted by* ***A*** *above in simple natural language.*

Question 2 (*25* points)

Consider the CFG, $\boldsymbol{G = (V,T,R,S)}$ *where*

$\boldsymbol{V = \{A, B, S\}}$, $\boldsymbol{T = \{a,b\}}$ *and* **R** *is given by the following productions:*

$\boldsymbol{S \rightarrow AB}$

$\boldsymbol{A \rightarrow aaAb \mid e}$

$\boldsymbol{B \rightarrow bbBa \mid a}$

(a) *(7 pts) Write down the CFL* $\boldsymbol{L_G}$ *generated by* **G** *above.*

(b) *(8 pts) Can the strings: (i)* $\boldsymbol{u_1 = a^4b^2a}$ *and (ii)* $\boldsymbol{u_2 = a^4b^4a^2}$ *be generated by* ***G?*** *If so draw the corresponding* **parse tree** *for these strings.*

(c) *(10 pts) Construct a PDA* $\boldsymbol{P = (Q, \Sigma, \Gamma, \delta, q_0, Z_0, F)}$ *that accepts the language* $\boldsymbol{L_G}$.

Question 3 (*25 points)*

(a) *(15 pts)* For the languages :

$\boldsymbol{L_1 = \{a^nb^{n+k}c^n;\ n,k \geq 0\}}$ *and* $\boldsymbol{L_2 = \{a^nb^kc^n\ ;\ n,k \geq 0\}}$

prove whether each is a CFL or not by using either the ***pumping lemma*** *or a CFG in* ***Chomsky Normal Form*** *that generates the language in question.*

(b) *(10 pts) For the right linear CFG* $\boldsymbol{G = (\{A,B,S\}, \{0,1\}, R, S)}$ *where* **R** *is given by :*

$\boldsymbol{S \rightarrow 0A \mid 1B\ ;\ A \rightarrow 0B \mid 1A \mid e\ ;\ B \rightarrow 1S \mid 1}$

draw an NFA **X** *that accepts the language* $\boldsymbol{L_G}$ *generated by* **G** *and then convert your* **X** *to a* ***minimal state*** *DFA* ***Y****.*

Question 4 (*25* points)

(a) *(10 pts)* State the definition of a ***Deterministic Turing Machine*** *(DTM)* to: *(i)* ***decide*** *a language ; (ii)* ***semidecide*** *a language ; and (iii)* ***compute*** a function $\boldsymbol{f: \Sigma_0^* \rightarrow \Sigma_0^*}$.

(b) *(7 pts) Construct a single tape DTM* **M** *either in graphical or tabular form that decides the language* $\boldsymbol{L = \{0^n1^n\ ;\ n \geq 0\}}$ *. Assume initial configuration as* $\boldsymbol{(s, \underline{\#}\, w)}$

(c) *(8 pts) Repeat part* ***(b)*** *when* $\boldsymbol{L = \{0^n1^{2n}\ ;\ n \geq 0\}}$ *.*