Formal Languages and Automata Theory
SS2020
Midterm, Variant 1
May 21st, 2020
Time Limit: 60 Minutes

Name: _____

Group: _1_____

This exam contains 6 questions. Total of points is 10.

Grade Table (for teacher use only)

Question	Points	Score
1	1	
2	1	
3	1	
4	1	
5	1	
6	5	
Total:	10	

Remarks:

- All subjects are mandatory.

- All the results must be accompanied with detailed solution.

- Carefully read and apply the instructions from the Midterm assignment on Google Classroom.

1. (1 point) (a) (0.75 point) Describe the language generated by the grammar $G = (V_N, V_T, S, P)$, where $V_N = \{S, A, B, C, D, E\}$, $V_T = \{a\}$, $S = S$, $P = \{S \to ACaB, Ca \to aaC, CB \to DB|E, aD \to Da, AD \to AC, aE \to Ea, AE \to \lambda\}$. (b) (0.25 points) Specify the type of the grammar and of the language from the previous exercise and locate them in the Chomsky hierarchy. Justify your answers.

2. (1 point) We have the grammar from Exercise 1 and the grammar $G_2 = (V_N, V_T, S, P)$, where $V_N = \{x_0, x_1, x_2\}$, $V_T = \{A, B, ..., Z\}$, $S = x_0$, $P = \{x_0 \to Ex_1, x_1 \to Nx_2, x_2 \to D\}$.

   (0.5 points) Compute L_2, the language generated by G_2. (0.5 points) Let L_1 be the language generated by the grammar from Exercise 1. Compute $L_1 \cup L_2$ by using the corresponding grammar and specify the type of the union grammar and language. Justify your answers.

3. (1 point) (0.5 points) Construct a grammar generating the language $L = \emptyset$. (0.5 points) Construct the finite automaton recognizing this language.

4. (1 point) (a) (0.2 points) Define deterministic, respectively, non-deterministic finite automata. (b) (0.3 points) Construct the non-deterministic finite automaton recognizing the language generated by the grammar specified by $V_N = \{S, A, B, C\}$, $V_T = \{0, 1, ..., 9, +, -\}$, $P = \{S \to +A| - A|A, A \to 0A|1A|...|9A|0|...|9\}$. (c) (0.3 points) Then, apply an algorithm studied in the class to transform it into a deterministic one. (d) (0.2 points) Give an example and a counterexample of a word of length 5 recognized, respectively, rejected by your DFA. Justify your answers.

5. (1 point) (a) (0.5 points) Construct an NFA recognizing the following language:

$$L = \{w|w \text{ is a binary string ending in } 1\}$$

   (b) (0.5 points) Use the automaton you constructed to construct a left-linear grammar generating the language above. Locate the grammar in the Chomsky hierarchy.

6. (5 points) (1 point) Write grammars of type 3 which generate the languages of your first name, last name and email address (Example: $\{Madalina\}$, $\{Erascu\}$, $\{madalina.erascu@e - uvt.ro\}$). (1 point) Starting from these grammars, write another grammar generating the language of your first, last name and email address (Example: $\{Madalina, Erascu, madalina.crascu@c - uvt.ro\}$). (0.25 points) What type is the grammar obtained? (0.25 points) What type is the language obtained? (0.25 points) Locate the language in Chomski hierarchy. Justify your answers.

(1.25 points) Starting from the grammar generating the first, last name and email address language construct the NFA. (1 point) Using the eager construction algorithm, transform the NFA into a DFA.