COMPSCI 2AC3
Instructor: Hassan Ashtiani
Final Exam
April 2022

Surname: _____

Given Name: _____

Student Number _____

- This examination paper includes 7 pages (including this cover page and the last blank page) and 5 questions. **You are responsible for ensuring that your copy of the papers is complete. Bring any discrepancy to the attention of your invigilator.**

- Examination duration is 120 minutes.

Exam Instructions:

- SINGLE VERSION exam

Materials Permitted in the Exam Venue:

- None.

Materials to be supplied to the students:

- Scrap paper

Instructions to the students:

- If you think there is an issue with one of the questions, make the best sensible assumption and write your assumption down along with your solution.

Grade Table

Question	Points	Score
1	45	
2	30	
3	10	
4	10	
5	15	
Total:	110	

1. (45 points) Which one is TRUE and which one is False? Clearly write either "TRUE" or "FALSE" besides each choice. No justifications are required.

   ○ If A is regular, then we can conclude that the set of double copies of strings in A (i.e., $B = \{xx \mid \in A\}$) is regular.

   ○ If A is regular, then we can conclude that A^2 is regular.

   ○ Any recursive language/set is also a recursively enumerable language/set.

   ○ A language has a Deterministic Finite Automata (DFA) if and only if it has a Non-deterministic Finite Automata (NFA).

   ○ A language has a Deterministic Pushdown Automata (DPDA) if and only if it has a Non-deterministic Pushdown Automata (NPDA).

   ○ Regular languages are closed under completion.

   ○ Recursive languages are closed under completion.

   ○ There is a Context Free Grammar in the Chomskey Normal Form for the following language $A = \{\varepsilon\}$ where ε is the null string.

   ○ There is a total Turing Machine M_1 that given the description of another Turing Machine M_2, can decide whether M_2 accepts the string aaa or not.

2. (30 points) We want to know the type of each of the following languages. For each choice clearly write either (i) "Regular", (ii) "Context Free" (but not regular), "Recursive" (but not context free), or "Not Recursive". No justifications are required.

○ $\{a^n b^n c^n \mid n \geq 1\}$

○ $\{a^n b^m c^p \mid n = p, m \geq 0\}$

○ $\{a, b, c\}^* - \{a^n b^n c^n \mid n \geq 0\}$

○ $\{a, b, c\}^*$

○ $\{a, b, c\}^* - \{a, b\}^*$

○ $\{a^p \mid p \text{ is prime}\}$

3. (10 points) Write a regular expression for the following set: $\{a, b, c\}^* - \{abc\}$. Simplify your answer. (no proof is required)

4. (10 points) Write a Context Free grammar for the following language: $\{a^m b^n c^p \mid m+n = p\}$ (no proof is required)

5. Consider the following language: $A = \{a, b, c\}^* - \{a^n b^n c^n \mid n \geq 0\}$

    (a) (5 points) Is A a context free language (CFL)? Write your answer clearly.

    (b) (10 points) (bonus question) If you think A is a CFL, then design a CFG for it (no proof is needed). Otherwise, if you think it is not a CFL prove your answer using pumping lemma for CFLs.

The End