CS/ECE 374 A ✧ Fall 2023

Practice Midterm 1

September 21, 2023

Name:	
NetID:	

- ***Don't panic!***
- You have 120 minutes to answer five questions. The questions are described in more detail in a separate handout.
- If you brought anything except your writing implements, your **hand-written** double-sided 8½" × 11" cheat sheet, and your university ID, please put it away for the duration of the exam. In particular, please turn off and put away *all* medically unnecessary electronic devices.
- Please clearly print your name and your NetID in the boxes above.
- Please also print your name at the top of every page of the answer booklet, except this cover page. We want to make sure that if a staple falls out, we can reassemble your answer booklet. (It doesn't happen often, but it does happen.)
- **Do not write outside the black boxes on each page**. These indicate the area of the page that our scanner can actually see. Anything you write outside the boxes will be erased before we start grading.
- If you run out of space for an answer, feel free to use the scratch pages at the back of the answer booklet, but **please clearly indicate where we should look**. Please ask for more scratch paper if you need it.
- Proofs or other justifications are required for full credit if and only if we explicitly ask for them, using the word ***prove*** or ***justify*** in bold italics.
- Please return ***all*** paper with your answer booklet: your question sheet, your cheat sheet, and all scratch paper. **Please put all loose paper *inside* your answer booklet.**

CS/ECE 374 A ✧ Fall 2023 Practice Midterm 1 Problem 1	Name:

Consider the function compress0s defined in the question handout. Let L be an arbitrary regular language.

(a) ***Prove*** that $\{w \in \Sigma^* \mid \text{compress0s}(w) \in L\}$ is regular.

(b) ***Prove*** that $\{\text{compress0s}(w) \mid w \in L\}$ is regular.

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For each of the following languages L over the alphabet $\Sigma = \{0, 1\}$, describe a DFA that accepts L **and** give a regular expression that represents L. You do not need to justify your answers.

(a) All strings in which at least one run has length divisible by 3.

(b) All strings that do not contain either `100` or `011` as a substring.

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Consider the recursive function Bond defined in the question handout.

(a) ***Prove*** that $|\text{Bond}(w)| \geq |w|$ for all strings w.

(b) ***Prove*** that $\text{Bond}(x \bullet y) = \text{Bond}(x) \bullet \text{Bond}(y)$ for all strings x and y.

CS/ECE 374 A ✧ Fall 2023 **Practice Midterm 1 Problem 4**	Name:

Let L be the language $\{0^a 1^b 0^c \mid a = b \text{ or } a = c \text{ or } b = c\}$

1. ***Prove*** that L is *not* a regular language.
2. Describe a context-free grammar for L. You do not need to justify your answer.

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For each statement below, check "Yes" if the statement is ***always*** true and check "No" otherwise, and write a ***brief*** (one short sentence) explanation of your answer. Read these statements very carefully—small details matter!

For any string $w \in (0+1)^*$, let w^C denote the string obtained by flipping every 0 in w to 1, and every 1 in w to 0.

(a) If $2+2=5$, then zero is odd.

Yes No

(b) $\{0^n1 \mid n > 0\}$ is the only infinite fooling set for the language $\{0^n10^n \mid n > 0\}$.

Yes No

(c) $\{0^n10^n \mid n > 0\}$ is a context-free language.

Yes No

(d) The context-free grammar $S \to 00S \mid S11 \mid 01$ generates the language 0^n1^n.

Yes No

(e) Every regular language is recognized by a DFA with exactly one accepting state.

Yes No

(f) Any language that can be decided by an NFA with ε-transitions can also be decided by an NFA without ε-transitions.

Yes No

(g) If L is a regular language over the alphabet $\{0,1\}$, then $\{xy^C \mid x, y \in L\}$ is also regular.

Yes No

(h) If L is a regular language over the alphabet $\{0,1\}$, then $\{ww^C \mid w \in L\}$ is also regular.

Yes No

(i) The regular expression $(00+11)^*$ represents the language of all strings over $\{0,1\}$ of even length.

Yes No

(j) Let L_1, L_2 be two regular languages. The language $(L_1+L_2)^*$ is also regular.

Yes No

(scratch paper)

(scratch paper)