CS/ECE 374 A ✧ Fall 2026

Midterm 1 Practice 3

September 27, 2026

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.)
- Proofs or other justifications beyond those listed in the standard grading rubrics are required if and only if we explicitly ask for them, using the word ***prove*** or ***justify*** in bold italics. **In particular, DFAs need to have mnemonic state names.**

- **Do not write outside the black boxes on each page**. These indicate the area of the page that our scanners will actually scan. If the scanner can't see your work, we can't grade it.
- If you run out of space for an answer, feel free to use the overflow/scratch pages at the back of the answer booklet, but **clearly indicate where we should look**. If we can't find your work, we can't grade it.
- **Only work that is written into the stapled answer booklet will be graded**. We **do not** recommend detaching pages from the answer booklet, because any work on those detached pages will not be graded (and it disrupts our process for uploading solutions to Gradescope.) Please let us know if you detach a page either on purpose or accidentally so we can reattach it.
- We will provide additional blank scratch paper on request, but we will not grade anything written on it.
- **Please return all paper with your answer booklet** including your question sheet, your cheat sheet, and all scratch paper. Please put this loose paper **inside** your answer booklet.

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or between or and and
or between or and or?

CS/ECE 374 A ✧ Fall 2026 Midterm 1 Practice 3 Problem 1	Name:

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

(a) Every integer in the empty set is prime.

Yes No

(b) The language $\{0^m1^n \mid m+n \le 374\}$ is regular.

Yes No

(c) The language $\{0^m1^n \mid m-n \le 374\}$ is regular.

Yes No

(d) For all languages L, the language L^* is regular.

Yes No

(e) For all languages L, the language L^* is infinite.

Yes No

(f) For all languages $L \subseteq \Sigma^*$, if L can be represented by a regular expression, then $\Sigma^* \setminus L$ is recognized by a DFA.

Yes No

(g) For all languages L and L', if $L \cap L' = \emptyset$ and L' is not regular, then L is regular.

Yes No

(h) Every regular language is recognized by a DFA with at least 374 accepting states.

Yes No

(i) Every regular language is recognized by an NFA with at most 374 accepting states.

Yes No

(j) Every context-free language has an infinite fooling set.

Yes No

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The *parity* of a bit-string w is `0` if w has an even number of `1`s, and `1` if w has an odd number of `1`s.

(a) Give a *self-contained*, formal, recursive definition of the *parity* function. (In particular, do ***not*** refer to # or other functions defined in class.)

(b) ***Prove*** that for every regular language L, the language $\textsc{OddParity}(L) := \{w \in L \mid \mathit{parity}(w) = \texttt{1}\}$ is also regular.

(c) ***Prove*** that for every regular language L, the language $\textsc{AddParity}(L) := \{\mathit{parity}(w) \cdot w \mid w \in L\}$ is also regular.

CS/ECE 374 A ✧ Fall 2026 Midterm 1 Practice 3 Problem 3	Name:

Let $L = \{w0^n w^R \mid w \in \{0,1\}^* \text{ and } n > 0\}$ where w^R denotes the reversal of string w.

(a) ***Prove*** that L is *not* a regular language.

(b) Describe a context-free grammar for L.

CS/ECE 374 A ✧ Fall 2026 Midterm 1 Practice 3 Problem 4	Name:

For any string $w \in \{0,1\}^*$, let take2skip2(w) denote the subsequence of w containing symbols at positions $1, 2, 5, 6, 9, 10, \ldots 4i+1, 4i+2, \ldots$. In other words, take2skip2(w) takes the first two symbols of w, skips the next two, takes the next two, skips the next two, and so on. Let L be an arbitrary regular language over $\{0,1\}$.

(a) ***Prove*** that the language $\textsc{Took2Added2}(L) := \left\{ w \in \Sigma^* \;\middle|\; \text{take2skip2}(w) \in L \right\}$ is regular.

(b) ***Prove*** that the language $\textsc{Took2Skipped2}(L) := \left\{ \text{take2skip2}(w) \;\middle|\; w \in L \right\}$ is regular.

CS/ECE 374 A ✧ Fall 2026 Midterm 1 Practice 3 Problem 5	Name:

For each of the following languages L over the alphabet $\{0, 1\}$, describe a DFA that accepts L **and** give a regular expression that represents L. You do **not** need to prove that your answers are correct, but you should give your DFA states mnemonic names.

(a) All strings in which every run of 1s has even length and every run of 0s has odd length. (Recall that a *run* is a maximal non-empty substring in which all symbols are equal.)

(b) All strings in 0^*10^* whose length is a multiple of 3.

(scratch paper)

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