CS3350 Automata
Spring 2026. Midterm II
04/13/2026 – 3:00PM to 4:20PM MDT

All documents allowed - Internet access NOT allowed

This midterm exam is open-book, **without** Internet access. All communication with other humans or AIs is prohibited. You need to submit your work on paper directly to your instructor at the end of the exam.

1. (17 points) Let $\Sigma = \{a, b, c\}$. Let L be the language defined by
$$L = \left\{ a^m b^n c^{m \bmod n} \middle|\, m, n \in \mathbb{N}, 2 \leq n \leq 5 \right\}.$$
Is L regular? Provide an answer and a proof for your answer.

2. (27 points) Let $\Sigma = \{a, b, c\}$. Let L be the language defined by
$$L = \left\{ a^m b^n c^{m \bmod n} \middle|\, m, n \in \mathbb{N} \right\}.$$
Is L regular? Provide an answer and a proof for your answer.

3. (22 points) Bring the following context-free grammar into Chomsky Normal Form, i.e. provide a context-free grammar that produces the same language and that is in Chomsky Normal Form.
$$\begin{array}{rcl} S & \to & SS \,|\, AB \\ A & \to & AA \,|\, C \\ B & \to & BAB \,|\, D \\ C & \to & abc \\ D & \to & de \end{array}$$

4. (20 points) Let be $\Sigma = \{0, 1\}$. Let $f_0, f_1, f_2, \ldots$ be the words over this alphabet that satisfy the following recurrence:
$$\begin{array}{rcl} f_0 & = & 0 \\ f_1 & = & 01 \\ f_n & = & f_{n-1} f_{n-2}. \end{array}$$
Typically, for $n \geq 2$, the word f_n is obtained by the concatenation of the word f_{n-1} and the word f_{n-2}.
Let $L \subseteq \Sigma^\star$ be the language of all the words f_i that satisfy that recurrence, i.e. let be
$$L = \{ f_i \in \Sigma^\star \,|\, f_0 = 0, f_1 = 01, f_n = f_{n-1} f_{n-2} \}.$$
The language L is called the Fibonacci language. Moll and Venkatesan have shown that L is neither regular nor context-free. Its definition looks like the definition of a context-free grammar though: $f_n \to f_{n-1} f_{n-2}$. Discuss which property in the definition of a context-free grammar is violated by the definition of the Fibonacci language.

5. (24 points) Let $M = (Q, \Sigma, \delta, q, F)$ be a deterministic finite automaton. Let $L = L(M) \subseteq \Sigma^\star$ the language accepted by the automaton M. Prove the following statement:
If there exists a word $w \in L$ with length $|w| \geq \#Q$, where $\#Q$ denotes the number of states in Q, then L contains infinitely many words.