

**CIS 301 – Theory of Computation - Exam 2**

1. [5 points] Determine whether the grammar implicitly defined by the following rules is ambiguous. Prove your answer.

$$\begin{aligned} S &\rightarrow AB \\ A &\rightarrow aA \\ A &\rightarrow abA \\ A &\rightarrow \varepsilon \\ B &\rightarrow bB \\ B &\rightarrow abB \\ B &\rightarrow \varepsilon \end{aligned}$$

2. [10 points] Show that the language defined below is **not** a regular language:

$$L = \{w = xy : x \in \{a, b\}^* \text{ and } y \in \{b, c\}^* \text{ also } |b| \text{ in } x = 2^* |a| \text{ in } x \\ \text{and } |b| \text{ in } y = 3^* |c| \text{ in } y\}$$

3. [10 points] Show a context-free grammar that generates L.

$$L = \{w \in \{0, 1\}^* : \text{the first, middle, and last characters of } w \text{ are identical} \}$$

4. [10 points] Give a PDA that recognizes the language  $\{a^i b^j c^k \mid i, j, k \geq 0 \text{ and } i+k=j\}$

5. [5 points] Show that the language defined below is **not** a regular language:

$$NOREPEAT = \{w \mid w \in \{0, 1\}^* \text{ and there is no } y \text{ such that } w = yy\}$$