

MIDTERM FOR CMSC 452

1. (30 points) For each of the following languages state either (1) It is regular, (2) It is CFL but not regular, or (3) It is not a CFL. NO PROOF REQUIRED. READ THESE DIRECTIONS: 3 points for every RIGHT answer. 0 points if you leave it blank. -3 points for every WRONG answer. ADVICE- DO NOT GUESS!!!)

- (a) $\{a^k b^m c^n : k, m, n \in \mathbb{N}\}$.
- (b) $\{a^k b^m c^n : k, m, n \in \mathbb{N} \text{ and } k + m = n\}$.
- (c) $\{a^k b^m c^n : k, m, n \in \mathbb{N} \text{ and } k + n = m\}$.
- (d) $\{a^k b^m c^n : k, m, n \in \mathbb{N} \text{ and } k < m < n\}$.
- (e) $\{a^k b^m c^n : k, m, n \in \mathbb{N} \text{ and } k + m + n \leq 1000\}$.
- (f) $\{a^k b^m c^n : k, m, n \in \mathbb{N} \text{ and } k + m + n \geq 1000\}$.
- (g) $\{a^{3n+7} : n \in \mathbb{N}\}$.
- (h) $\{a^{n^2} : n \in \mathbb{N}\}$.
- (i) $SUBSEQ(\{a^n b^n : n \in \mathbb{N}\})$
- (j) The language generated by the following CFG:

$S \rightarrow aS$
 $S \rightarrow bS$
 $S \rightarrow A$
 $A \rightarrow Ac$
 $A \rightarrow e$

2. (25 points) Let L_1 be a CFL via CFG (N_1, Σ, P_1, S_1) . Let L_2 be a CFL via CFG (N_2, Σ, P_2, S_2) . Construct a CFL for

$$L = \{w_1 w_2 : w_1 \in L_1 \text{ and } w_2 \in L_2\}.$$

You do not need to prove that it works but it should be clear that it does.

3. (25 points) Recall that in class we had the notation that a finite set was represented by a string of bits (1 for IN, 0 for OUT). For example 11001 is the set $\{0, 1, 4\}$. Also recall that we can represent pairs of sets using the alphabet $\{00, 01, 10, 11\}$ (written up and down). For example

$$\begin{array}{cccc} 1 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 \end{array}$$

represents the pair of sets $\{0, 1\}, \{1, 3\}$.

Using this notation draw a DFA for the language $L = \{(A, B) : A \subseteq B\}$.

(Note that all inputs are valid.)

4. (20 points) Let L be recognized by a PDA via PDA $(Q, \Sigma, \Gamma, \delta, s, F)$. Construct a PDA for L^* . You do not need to prove that it works but it should be clear that it does.