Fall 2024 COT 4210 Exam #2
October 1, 2024
Sheet 1: Context Free Grammars

Last Name: _____ , First Name: _____

1) (10 pts) Design a CFG over the alphabet {a, b, c} for the following language:

L = { $a^n b^x c^y a^n$ | $n \geq 0$, $x \geq 0$, $y \geq 0$ }. Please make your start symbol S.

2) (25 pts) Convert the grammar shown below to Chomsky Normal Form. S is the start symbol, the alphabet is {a, b} and V = {S, A, B, C}

S → ABC
A → ABBA | aB
B → BB | ab | ε
C → B | b

Clearly label your answer after each of the following stages: (1) new start variable, (2) Removing ε rules, (3) Remove unit rules, (4) Add additional variables and rules so no right hand side has more than 2 variables.

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Sheet 2: Push Down Automatas

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3) (15 pts) Design a PDA over the alphabet {a, b, c} which accepts the following language:

$L = \{ a^x b^y c^z \mid x = y + z, x > 0, y \geq 0, z \geq 0, y + z > 0 \}$. Give the FULL formal definition of the PDA. Namely, explicitly list out Q, Σ, Γ, δ, q_0 and F.

4) (15 pts) Convert the CFG shown below with start symbol S, alphabet {a, b}, V = {} to an equivalent PDA using the algorithm shown in class. Just draw the corresponding PDA and no need to label any states except for q_{start} (start state), q_{loop} and q_{accept} (only accept state). When labeling your transition arrows, please use the format x, y → z, where x is what is read in, y is what is popped from the stack and z is what is pushed onto the stack.

S → a | SAB
A → b | BB
B → a | ε

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Sheet 3: Pumping Lemma for Context Free Languages

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5) (15 pts) Use the Pumping Lemma for Context Free Languages to prove that the following language over the alphabet $\{0\}$ is not context free:

$$L = \{0^{n^2} | n \geq 0\}$$

6) (15 pts) Use the Pumping Lemma for Context Free Languages to prove that the following language over the alphabet {0, 1} is not context free:

$$L = \{0^{4n}1^{2n}0^{n} | n \geq 0\}$$

7) (5 pts) In what city is the world famous San Diego Zoo? _____