CSci 435: Formal Languages and Automata

Instructor: Dr. M. E. Kim Date: October 3rd, 2018

Due: 5:00 PM, October 10th (Wed.), 2018. (No Extension) Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Home Assignment 3: 150 points + 10 points (optional)**

Q1. [30] Show that the following languages are context-free, by giving the context-free grammar that generates it. *n, m, k* ≥ 0

1. [10] L1 = { *anbn* | *n* is a multiple of *3* }
2. [10] L2= { *anbmck* | *n=m* or *m* ≤ *k* }
3. [10] L3 = { *anbmck* | *k =* |*n – m*| }
4. [10, optional] L4 = L2 ∪ L3 from (2) & (3)

Q2. [10] Give the language L that is generated by the given grammar.

S → *aa*S*bb* | SS |λ.

Q3. [10] Find an s-grammar for L(*aaa*\**b* + *ab*\*).

Q4. [30] For a given grammar below,

G = ( {S, A, B}, {*a, b*}, S, P ) with productions

S → AB | *bbbB*, A → *b* | A*b*, B → *a..*

1. [10] Show the grammar G is ambiguous.
2. [10] Give language L that is generated by G, L = L(G), in a formal expression (including a regular expression).
3. [10] Construct an unambiguous grammar that is equivalent to G.

Q5. [10] In the given grammar, draw a derivation tree for the string *ababbac*.

G = ( {A, B}, {*a, b, c*}, A, P ) with productions

A → *a* | *aa*A| *~~ab~~*~~A~~*~~c~~* ***abBc*** , B → *abb*A | *b.*

Q6. [35] In the given grammar below, generate the simplified equivalent grammar by eliminating the following productions through (1) – (3).

G = ( {S, A, B, C}, {*a, b*}, S, P ) with productions

S → bB | *b*AA , A → *a*A| *aaC* , B → *bb*B | *λ,* C → A

1. [10] Eliminate the λ-productions
2. [10] Eliminate the Unit-productions from (1)
3. [10] Eliminate the useless productions (2), so that give the simplified equivalent grammar.
4. [5] Give the language L that is generated by this grammar, L = L(G), in a formal expression (including a regular expression).

Q7. [15] Convert the given grammar into Chomsky Normal Form (CNF).

S → AB | *a*B, A → *abb* | *λ* , B → *bb*A

Hint: Eliminate the λ-productions and/or any unit-production prior to their conversion into CNF.

Q8. [10] Convert the given grammar into Greibach normal form.

S → *a*S*b* | *ab* | *bb*