CSci 435: Formal Languages and Automata

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**Home Assignment 4: 150 points + 10 points (optional)**

Q1. [20] For a given language L = {*anb****2n*** | *n* ≥ 0 is even}.

1. [8] Give a CFG that accepts L.
2. [6] Show the sequence of derivations for the acceptance of *aaaabbbbbbbb* by G in (1).
3. [6] Draw a derivation tree for *aaaabbbbbbbb*.

Q2. [30] Construct a CFG for the following languages where *n*, *m, k* ≥ 0.

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

Q3. [10] Give the language L that is generated by the given grammar, in a formal expression.

S → *aa*S*bb* | SS |λ.

e.g.) L = { *w* ∈ {*a, b*}\* | *na*(*w*) = 2*nb*(*w*) }

Q4. [10] Find an s-grammar for L = {*anb****2n*** | *n* ≥ 2}.

Q5. [20] For a grammar G with the productions where G = ( {S, A, B}, {*a, b*}, S, P ) with productions

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

1. [8] Show that the grammar G is ambiguous.
2. [6] Give language L that is generated by G, L = L(G), in a formal expression (including a regular expression).
3. [6] Can you construct an unambiguous grammar that is equivalent to G? Otherwise, show that G is inherently ambiguous.

Q6. [35] In the given grammar G, 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 →*b*AA | *b*B, 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*