MC304 Theory of Computation

Assignment-III

1. Find context-free grammars for the following languages (with $n \geq 0, m \geq 0$).

   (a) L = $\{a^n b^m : n \neq m1\}$

   (b) L = $\{a^n b^m : 2n \leq m \leq 3n\}$

   (c) L =$\{w \in \{a, b\}^* : n_a(w) = 2n_b(w) + 1\}$

2. Reduce the following grammars to Chomsky Normal Form.

   (a) $S \to 1A|0B, A \to 1AA|0S|0, B \to 0BB|1S|1$

   (b) $S \to a|b|cSS$

3. Reduce the following grammars to Greibach Normal Form.

   (a) $S \to SS|0S1|01$

   (b) $S \to AB, A \to BSB|BB|b, B \to aAb|a$

4. Show that the following grammars are ambiguous.

   (a) $S \to a|abSb|aAb, A \to bS|aAAb$

   (b) $S \to aB|ab, A \to aAB|a|, B \to ABb|b$

5. Use Pumping lemma to show that following are not context free languages:

   (a) $\{a^{n^2} | n \geq 1\}$

   (b) $\{a^m b^m c^n | m \leq n \leq 2m\}$

6. Construct pda's that accept the following languages on $\Sigma = \{a, b, c\}$.

   (a) $\{w : n_a(w) = 2n_b(w)\}$

   (b) $\{wcw^R : w \in \{a, b\}^*\}$

   (c) $\{a^n b^{n+m} c^m : n \geq 0, m \geq 1\}$

7. If the initial ID of the pda A is $(q_0, aacaa, Z_0)$.what is the ID after processing of $aacaa$?If the input string is $(i)abcba, (ii)abcb, (iii)acba, (iv)abac, (v)abab$,will A process the entire string?If,so what will be the final ID?

$$A = (\{q_0, q_1, q_f\}, \{a, b, c\}, \{a, b, Z_0\}, \delta, q_0, Z_0, F)$$

   where δ is defined as:

$$\delta(q_0, a, Z_0) = \{(q_0, aZ_0)\} \qquad \delta(q_0, b, Z_0) = \{(q_0, bZ_0)\}$$
$$\delta(q_0, a, a) = \{(q_0, aa)\} \qquad \delta(q_0, b, b) = \{(q_0, bb)\}$$
$$\delta(q_0, a, b) = \{(q_0, ab)\} \qquad \delta(q_0, b, a) = \{(q_0, ba)\}$$
$$\delta(q_0, c, a) = \{(q_1, a)\} \qquad \delta(q_0, c, b) = \{(q_1, b)\}$$
$$\delta(q_0, c, Z_0) = \{(q_1, Z_0)\} \qquad \delta(q_1, \wedge, Z_0) = \{(q_f, Z_0)\}$$
$$\delta(q_1, a, a) = \delta(q_1, b, b) = \{(q_1, \wedge)\}$$

Present State	Tape Symbol		
	b	0	1
$\to q_1$	$1Lq_2$	$0Rq_1$	
q_2	bRq_3	$0Lq_2$	$1Lq_2$
q_3		bRq_4	bRq_5
q_4	$0Rq_5$	$0Rq_4$	$1Rq_4$
q_5	$0Lq_2$		

8. Draw the transition diagram for Turing machine given below:

9. Construct a Context-free grammar G accepting $N(M)$ for the pda M given below:

$$A = (\{q_0, q_1, q_f\}, \{a, b\}, \{a, Z_0\}, \delta, q_0, Z_0, q_f)$$

where δ is defined as:

$$\delta(q_0, a, Z_0) = \{(q_0, aZ_0)\} \qquad \delta(q_1, b, a) = \{(q_1, \wedge)\}$$
$$\delta(q_0, a, a) = \{(q_0, aa)\} \qquad \delta(q_1, \wedge, Z_0) = \{(q_1, \wedge)\}$$
$$\delta(q_0, b, a) = \{(q_1, \wedge)\}$$

10. Construct the computation sequence for strings $1213, 2133, 312$ for the Turing machine given below:

Present State	Input Tape Symbol			
	1	2	3	b
$\to q_1$	bRq_2			bRq_1
q_2	$1Rq_2$	bRq_3		bRq_2
q_3		$2Rq_3$	bRq_4	bRq_3
q_4			$3Lq_5$	bLq_7
q_5	$1Lq_6$	$2Lq_5$		bLq_5
q_6	$1Lq_6$			bRq_1
q_7				