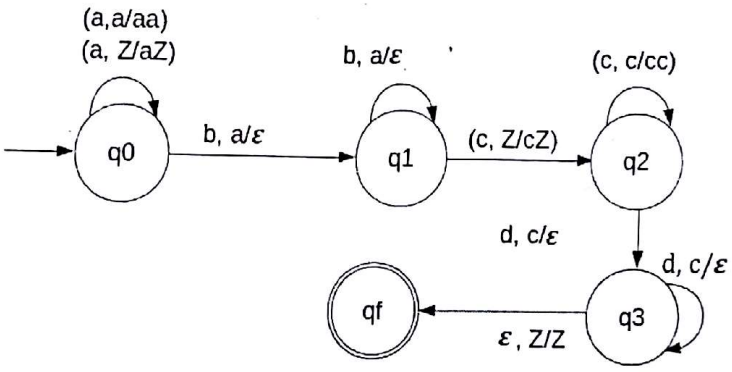
BRAC University
Department of CSE
Fall 2016 Final Examination
CSE 331- Automata and Computability
[Answer any 6] **Time: 2.00 hr 15 min**
Student ID: 11110005 **Total marks 60**

1. a) Convert the grammar with productions into Chomsky normal form. [8]

$S \rightarrow abAB$
$A \rightarrow bAB|\epsilon$
$B \rightarrow BAa|A|\epsilon$

b) Write the language represented by this PDA. [2]



2. a) Transform the grammar with productions into CNF form [2+6+2]

$S \rightarrow aSb|b$

b) Use the CYK algorithm to determine if the string w = aabbbb is in the language generated by the above CNF grammar.

c) Why CNF format is important to define a grammar? Just write in points.

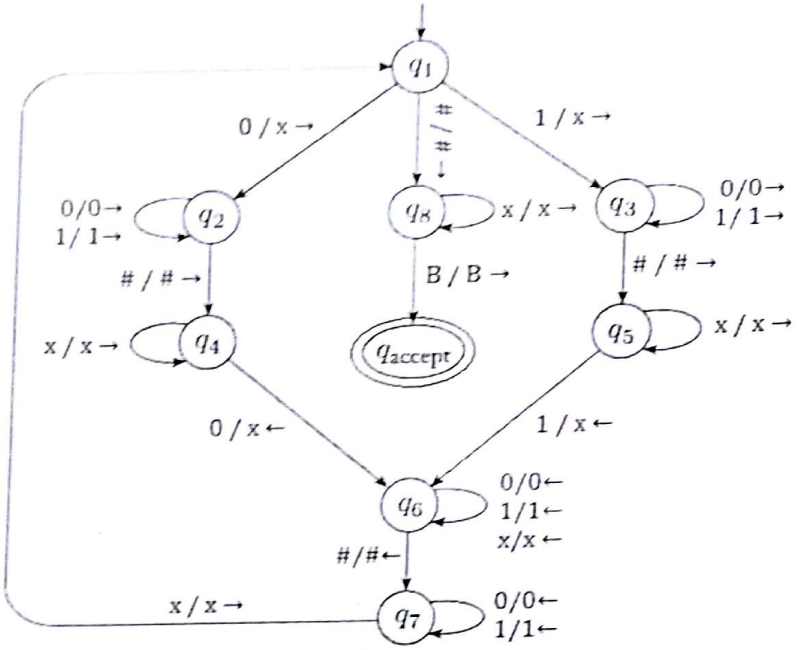
3. M is a Turing Machine with following description:

$M = (Q, \Sigma, \Gamma, \delta, q_1, B, q_{accept})$
$Q = \{q_1, q_2, q_3, q_4, q_5, q_6, q_7, q_8, q_{accept}\}$, $\Sigma = \{0, 1, \#\}$, $\Gamma = \{0, 1, \#, x, B\}$

a) Simulate the following turing machine for the input 110#110 [7]

b) Will the machine accept the string ? [1]

c) Describe the language of the machine. [2]

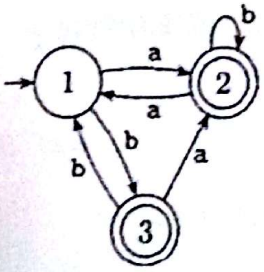


4. a) Design DFA to accept the following languages: [5+5=10]

i) L={w| w doesn't contain 1010 as substrings, starts with 0 and ends with 1 }

ii) L={ All strings that contain the substring 110 or at least 2 0's}

b) Using state elimination method, convert the DFA into an equivalent regular expression.



5. a) Write regular expression for the following languages, Σ= {0,1} [4+6=10]

i) The set of strings containing at least 4 1's.

ii) The set of strings containing 00 or 01 as a substring.

b) Consider the following regular expressions, draw a DFA or a NFA for each of the following.

i) $a^*(ab + ba + a)\, b^*$, Σ= {a,b}

ii) $(01)^* + (10)^*$, Σ= {0,1}

iii) $(00 + 1)^*$

6. a) Consider the following grammar: (start symbol D), $\sum$ = {c, a, b, . . 0, 1} [3+3+3]

$D \rightarrow TL$
$T \rightarrow c \mid Tc$
$L \rightarrow L.V \mid V$
$V \rightarrow a \mid b \mid 0 \mid 1 \mid Va \mid Vb \mid V0 \mid V1$

Show the leftmost derivation, rightmost derivation and parse tree for the string: cabb0011.ab1

b) How can we determine if a grammar is ambiguous? [1]

7. a) Design a Push Down Automata (PDA) to recognize the following language
$L=\{a^m b^{m+n} c^n \mid m>=1, n>=1\}$, $\sum = \{a,b,c\}$

Show the contents of the stack in each step, when the input is "aabbbc" [5+1]

b) Convert the following CFG grammar to a PDA. (start symbol E, $\sum$ = {a,b,+}) [4]

$E \rightarrow aAa \mid bbB \mid B+B$
$A \rightarrow C$
$B \rightarrow aBb \mid aBD \mid AB \mid \epsilon$
$C \rightarrow E \mid \epsilon$
$D \rightarrow abD \mid D$

8. a) Show that the following grammar G is ambiguous by taking any string from the language L(G) and showing two leftmost derivations or two parse trees for the string. (Starting symbol S)

$S \rightarrow aFbS \mid aFbSaS \mid \epsilon$
$F \rightarrow f$ [5]

b) i) Define ID of a PDA. [1]

ii) Consider a PDA $p = (\{q_0, q_1, q_2, q_3\}, \{a,b,c\}, \{a,b,c,z_0\}, \delta, q_0, z_0, \{q_3\})$ with following transition function: [3]

$\delta(q_0, a, z_0) = (q_0, az_0)$

$\delta(q_0, a, a) = (q_0, aa)$

$\delta(q_0, b, a) = (q_1, ba)$

$\delta(q_1, b, b) = (q_1, bb)$

$\delta(q_1, c, b) = (q_2, \varepsilon)$

$\delta(q_2, c, b) = (q_2, \varepsilon)$

$\delta(q_2, c, a) = (q_2, \varepsilon)$

$\delta(q_2, \varepsilon, z_0) = (q_3, z_0)$

Starting from the initial ID (q_0, w, z_0), show all the reachable ID's when the input string w is: abbbcccc .

iii) Will the PDA accept the string? [1]

9. **a)** State the pumping lemma for regular language. The language L is defined as $L = \{0^n 1^{3n} \mid n \geq 1\}$. Prove using the pumping lemma that L is not a regular language. [2+4]

b) Consider the grammar (V, ∑, R, S), where V, ∑ and R as defined as follows: [2+2]

V = {S, A}, ∑= {a,b}

S → aAa
S → bAb
S → SS
S→ ε

Is it possible to generate the following strings? If not, why? If yes, give the derivation

i) baababba
ii) baabbbab

10. **a)** Construct context free grammar (CFG) for the following languages. [2.5+2.5+2.5]

i) All strings with exactly one occurrence of the substring bbb. ∑ = {a,b}

ii) All strings with a number of a's divisible by four. ∑ = {a,b}

iii) All strings with more a's than b. ∑ = {a,b}

b) Consider an alphabet definition as ∑={0,1}. What do you understand by Σ^*, Σ^2, Σ^3. [2.5]