SRM Institute of Science and Technology

18CSC301T - Formal Language and Automata Theory

CT2 - Answer key - Set B

1. $S \rightarrow NP\ VP$

$NP \rightarrow DT\ N \mid NP\ PP$

$PP \rightarrow PRP\ NP$

$VP \rightarrow V\ NP \mid VP\ PP$

$DT \rightarrow a \mid the$

$N \rightarrow lion \mid deer \mid Tree$

$PRP \rightarrow under \mid with \mid above$

$V \rightarrow ate \mid saw \mid ran$

(i) c. The stack in the PDA can containg stack Symbols and input symbols. (1)

(ii) b. 2 — 1 mark

(iii) 5 marks

$PDA = \{\{q_0\}, \{a, the, lion, deer, Tree, under, with, above, ate, saw, ran\}, \delta, q_0, z_0, \Gamma, \phi_F\}$

$\Gamma = \{z_0, S, NP, PP, VP, DT, N, PRP, V\} \cup \Sigma$

Variables

δ

$\delta(q_0, \varepsilon, z_0) = (q_0, S)$

$\delta(q_0, \varepsilon, S) = (q_0, NP\ VP)$

$\delta(q_0, \varepsilon, NP) = (q_0, DT\ N)$

$\delta(q_0, \varepsilon, NP) = (q_0, NP\ PP)$

$\delta(q_0, \varepsilon, PP) = (q_0, PRP\ NP)$

$\delta(q_0, \varepsilon, VP) = (q_0, V\ NP)$

$\delta(q_0, \varepsilon, VP) = (q_0, VP\ NP)$

$\delta(q_0, \varepsilon, DT) = (q_0, a)$

$\delta(q_0, \varepsilon, DT) = (q_0, the)$

$\delta(q_0, \varepsilon, PRP) = (q_0, under)$

$\delta(q_0, \varepsilon, PRP) = (q_0, with)$

$\delta(q_0, \varepsilon, PRP) = (q_0, above)$

$\delta(q_0, \varepsilon, V) = (q_0, ate)$

$= (q_0, saw)$

$= (q_0, ran)$

$\delta(q_0, \varepsilon, N) = (q_0, lion)$

$\delta(q_0, \varepsilon, N) = (q_0, deer)$

$\delta(q_0, \varepsilon, N) = (q_0, tree)$

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

$\delta(q_0, the, the) = (q_0, \varepsilon)$

$\delta(q_0, lion, lion) = (q_0, \varepsilon)$

$\delta(q_0, tree, tree) = (q_0, \varepsilon)$

$\delta(q_0, under, under) = (q_0, \varepsilon)$

$\delta(q_0, with, with) = (q_0, \varepsilon)$

$\delta(q_0, above, above) = (q_0, \varepsilon)$

$\delta(q_0, under, under) = (q_0, \varepsilon)$

$\delta(q_0, ate, ate) = (q_0, \varepsilon)$

$\delta(q_0, saw, saw) = (q_0, \varepsilon)$

$\delta(q_0, ran, ran) = (q_0, \varepsilon)$

$\delta(q_0, \varepsilon, z_0) = (q_0, \varepsilon)$

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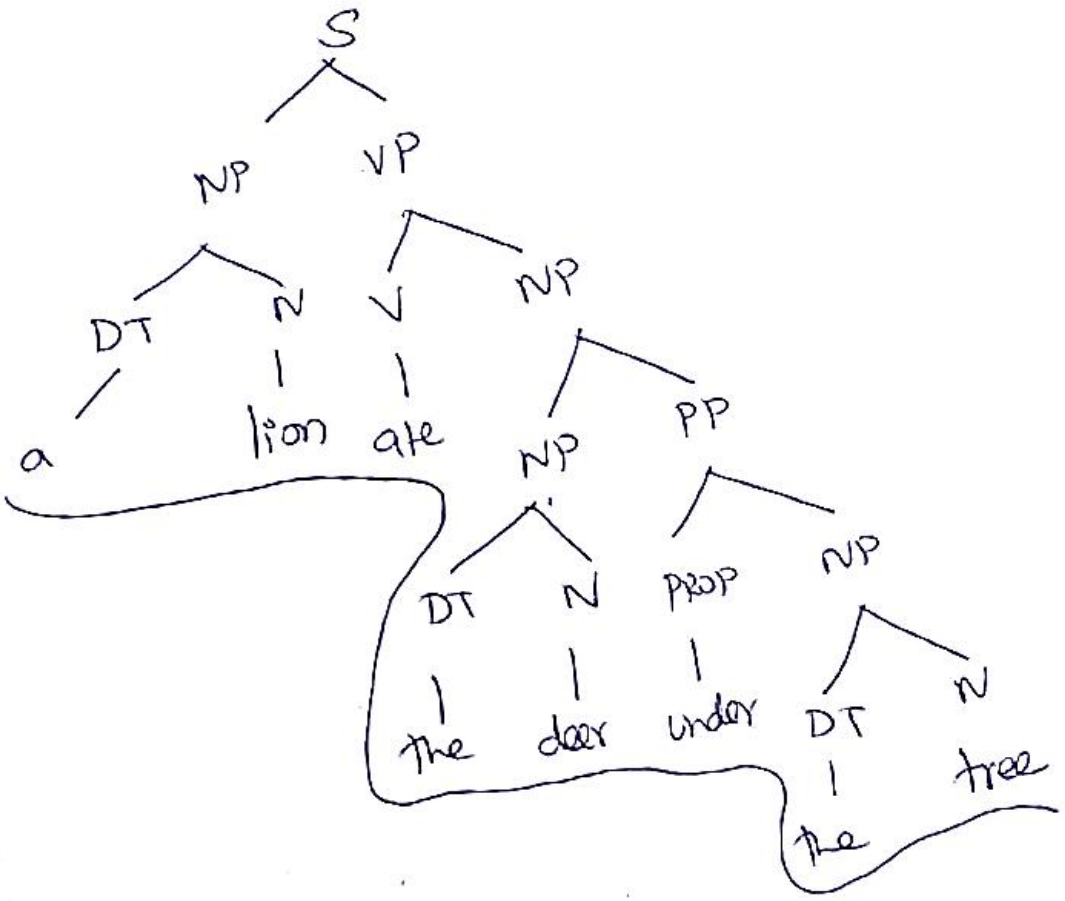
iv) Terminals = {a, the, lion, deer, tree, under, with, above, ate, saw, ran}

Non Terminals = {S, NP, PP, VP, DT, N, PRP, V}

-3marks

v)



vi) Simplification

i) Elimination of useless symbols

→ No non-generating and no not reachable symbols

ii) Elimination of ε production

→ No ε production

iii) Elimination of unit production

→ No unit production

vii) Chomsky Normal Form (CNF)

→ given grammar already in CNF form

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2. $L = \{a^n b^{2n} \mid \Sigma = \{a, b\}^*\}$

i) a. The number of symbols in LHS of CFG must always be less than or equal to symbols in RHS.

ii) c. I is false and II is true

iii) Context Free Grammar:

$S \rightarrow aSbb \mid abb$

(or)

$S \rightarrow aAbb$

$A \rightarrow aAbb \mid \varepsilon$

IV) Simplification of grammar:

If grammar is

$S \to aSbb \mid abb$

1) Elimination of useless symbols
→ no non generating,
no - not reachable
symbol

2) Elimination of ε production
→ No ε production

3) Elimination of unit production
→ no unit production

V) to GNF first grammar should be in CNF

CNF $A \to a \quad B \to b$

$X_1 \to AS \quad X_2 \to BB$

$S \to X_1 X_2 \mid AX_2$

GNF $A \to a \quad B \to b$

$X_1 \to aS \quad X_2 \to bB$

$S \to aSX_2 \mid aX_2$

(or) If grammar is

$S \to aAbb$

$A \to aAbb \mid \varepsilon$

1) Elimination of useless symbols
→ no non-generating & no
not reachable symbols

2) Elimination of ε production
$A \to \varepsilon$

$S \to aAbb \mid abb$

$A \to aAbb \mid abb$

3) Elimination of unit production
→ no unit production

V) to convert any grammar to GNF the grammar should be in CNF

CNF $A \to a \quad B \to b$

$X_1 \to AS \quad X_2 \to BB$

$S \to X_1 X_2 \mid AX_2$

$A \to X_1 X_2 \mid AX_2$

GNF $A \to a \quad B \to b$

$X_1 \to aS \quad X_2 \to bB$

$S \to aSX_2 \mid aX_2$

$A \to aSX_2 \mid aX_2$

3. Case1: $R^m G^n V^{4n} Y^{2m}$ | Case2: $R^n G^{3n}$

i) b. The PDA's constructed for case1 and case2 are deterministic

ii) d. Nothing can be inferred

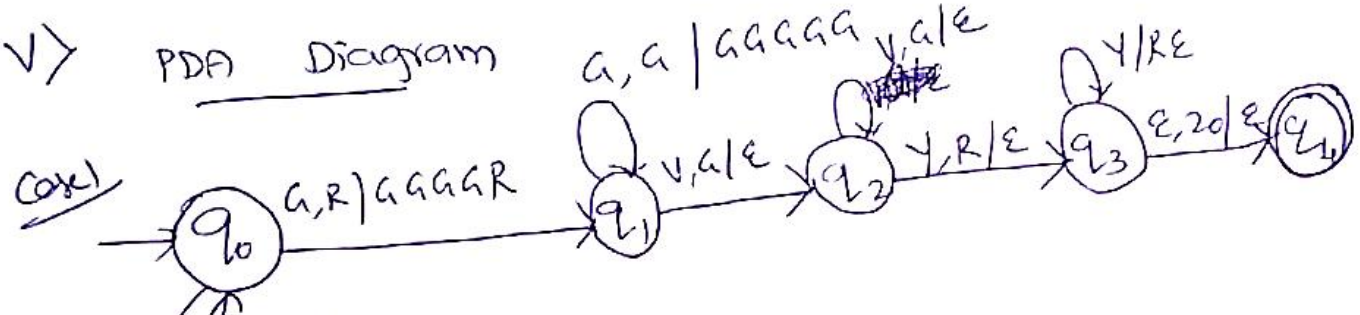
iii) case1:

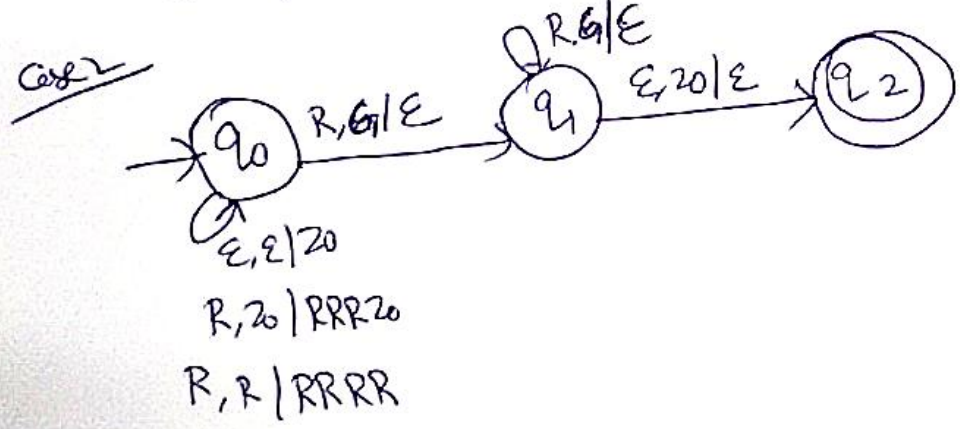
$L = \{R^m G^n V^{4n} Y^{2m} \mid \Sigma = \{R, G, V, Y\}\}$

case2:

$L = \{R^n G^{3n} \mid \Sigma = \{R, G, V, Y\}\}$

V) PDA Diagram





Vi) PDA for servior → represent tuple notation for above

$PDA = \{Q, \Sigma, \delta, q_0, Z_0, \Gamma, F\}$

vi) $w = RRGGGG$

Case 1

ID

$(q_0, RRGGGG, \varepsilon)$

$\downarrow$

$(q_0, RRGGGG, Z_0)$

$\downarrow$

$(q_0, RGGGG, RRZ_0)$

$\downarrow$

$(q_0, GGGG, RRRRZ_0)$

$\downarrow$

$(q_0, GGG, GGGGRRRRZ_0)$

$\downarrow$

$(q_0, GG, GGGGGGGGRRRRZ_0)$

$\downarrow$

$(q_0, G, GGGGGGGGGGGGRRRRZ_0)$

$\downarrow$

$(q_0, \varepsilon, GGGGGGGGGGGGGGGGRRRRZ_0)$

$\downarrow$

at end of input transition not in final state and stack is not empty too.

Hence given i/p will be rejected.

$\times$