SRMIST - School of Computing

Set C

Answerkey - 18CSC301T - FLA

① CFG - parse tree always binary tree ~~often~~ - to be converted to CNF

$E \to E+T \mid T$
$T \to T*F \mid F$
$F \to (E) \mid a$

} not useless symbols, no ~~unit~~ ε production

Elimination of unit production

$F \to (E) \mid a$

$T \to T*F \mid (E) \mid a$

$E \to E+T \mid T*F \mid (E) \mid a$

CNF conversion

$X_1 \to ($
$X_2 \to)$
$X_3 \to *$
$X_4 \to +$
$X_5 \to X_1E$
$X_6 \to TX_3$
$X_7 \to EX_4$

$F \to (E) \mid a$

$F \to X_1EX_2 \mid a$

$\boxed{F \to X_5X_2 \mid a}$

$T \to T*F \mid (E) \mid a$

$T \to TX_3F \mid X_5X_2 \mid a$

$\boxed{T \to X_6F \mid X_5X_2 \mid a}$

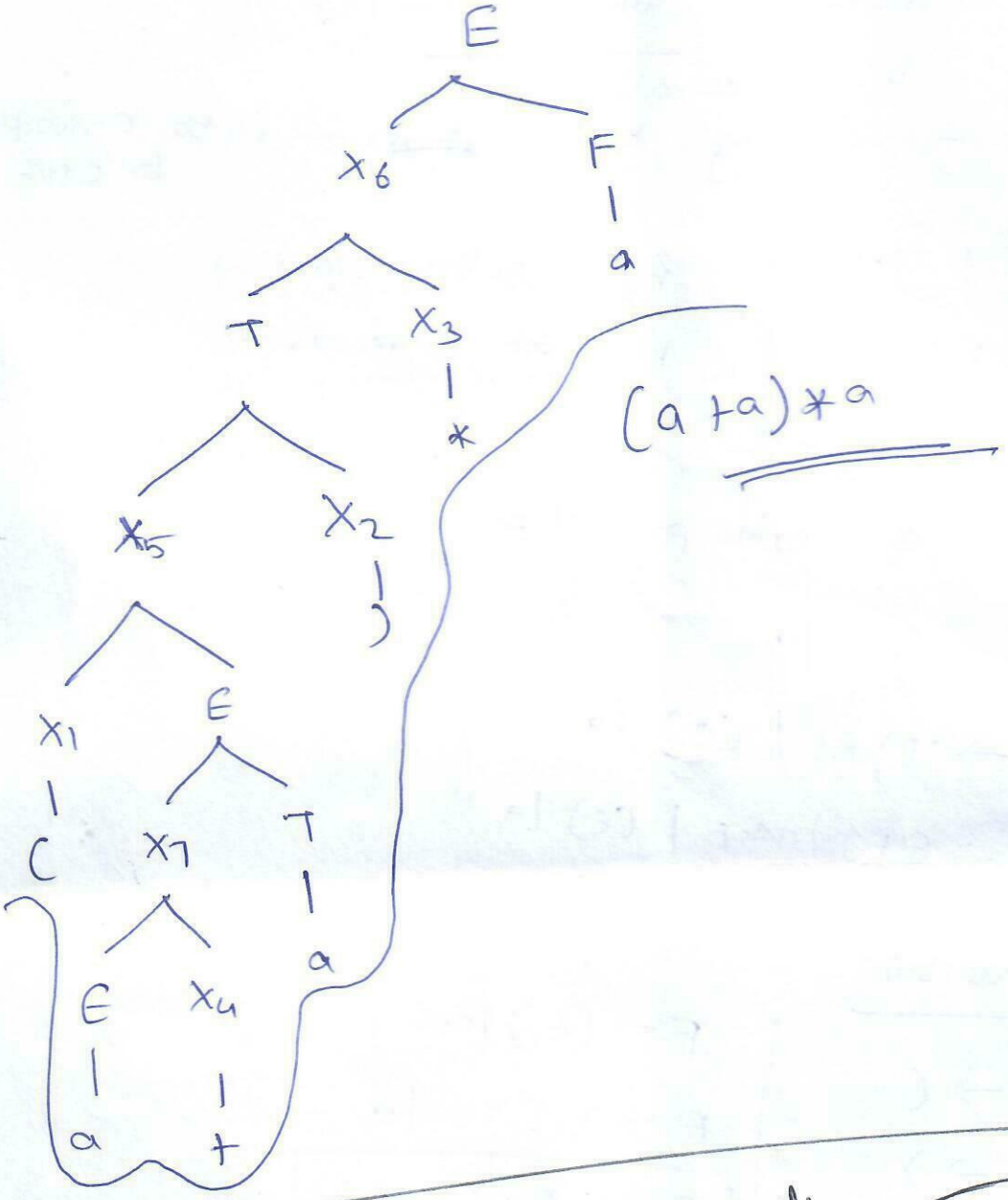
$E \to E+T \mid T*F \mid (E) \mid a$

$E \to EX_4T \mid X_6F \mid X_5X_2 \mid a$

$\boxed{E \to X_7T \mid X_6F \mid X_5X_2 \mid a}$

⟹ 5 marks

- Parse Tree — 5 marks



(a + a) * a

---

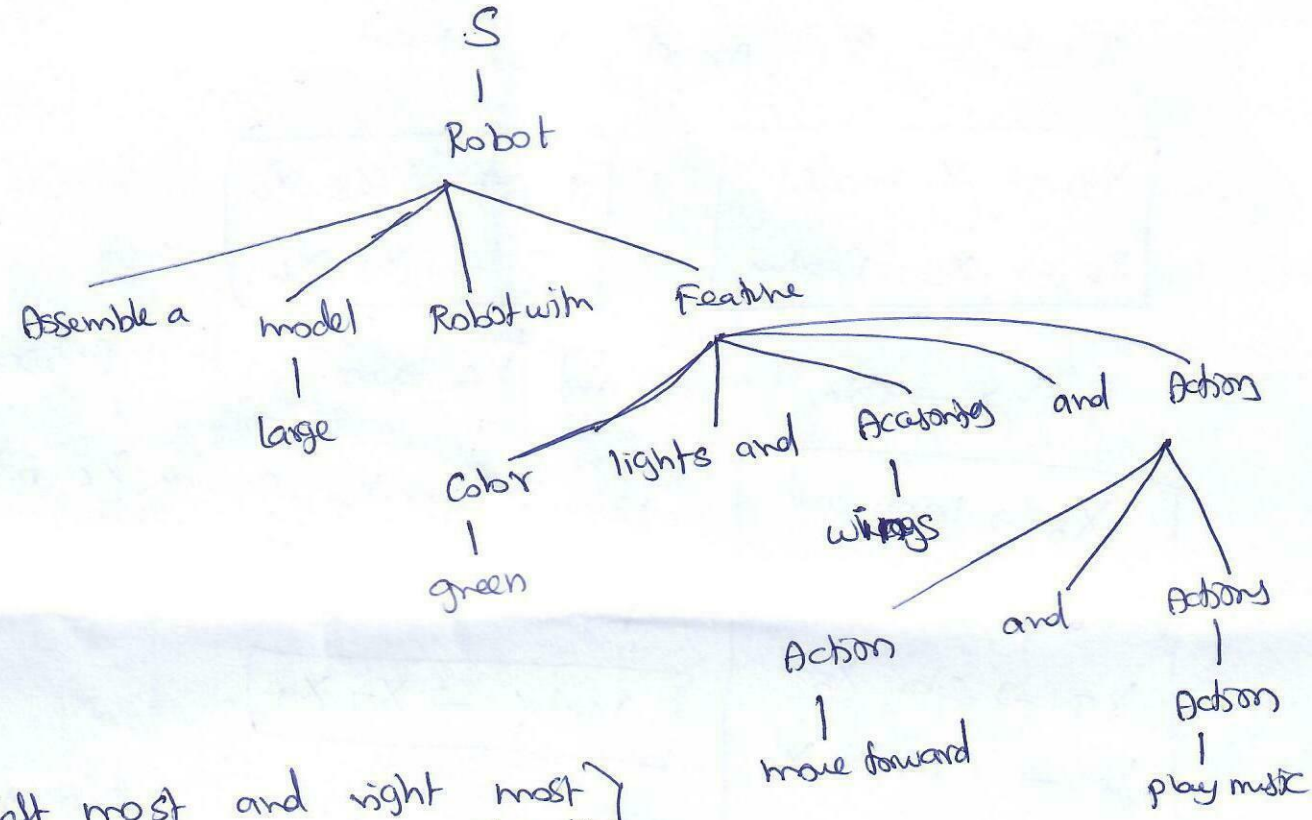
(2) a. Terminals and non terminals (4 marks)

Terminals = { Assemble a, robot with, small, medium sized, large, lights and, and, red, blue, green, yellow, wheels, antennas, legs, wings, dance, spin, move forward, play music }

non-Terminals or Variable = { S, Robot, model, Features, Color, Accessories, Actions, Actions }

(b) Assemble a large robot with green lights and wings and move forward and play music

Parse tree



→ Left most and right most derivation

4 marks

(c) Simplification of grammar

5 marks

→ not useless symbols

→ no ε production

unit production.

S → Robot & Actions → Action

Elimination

S → "Assemble a" model "robot with "feature".

Action → Action "and" Actions | dance | spin | move forward | play music

(4) CFG to CNF

5 marks

Robot → Assemble a "model" "robot with" Feature

X_1 → Assemble a

X_2 → robot with

Robot → X_1 model X_2 Featu.

X_3 → X_1 model

X_4 → X_2 Featu

Robot → X_3 X_4

S → X_3 X_4

Feature → Color "light and" Accessories "and" Actions

X_5 → lights and

X_6 → and

X_7 → Color X_5

X_8 → Accessories X_6

X_9 → X_8 Actions

Featu → color X_5 Accesm X_6 Actions

Featu → X_7 X_8 Actions

Featu → X_7 X_9

Actions → Action "and" Actions

Actions → Action X_6 Actions

X_{10} → Action X_6

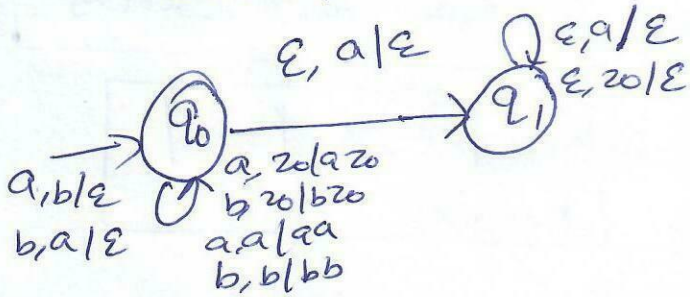
Actions → X_{10} Actions

---

(3) Professor Ram

(a) open parantess → as 'a'
closed paranthe → as 'b'

no of 'a' > 'b' and 'a' and 'b' in any order.



→ 5 marks

Tuple notation → (3 marks)

$PDA = \{\{q_0, q_1\}, \{a, b\}, \{z_0, a, b\}, \delta, q_0, z_0, \phi\}$

Q $\quad \Sigma$ $\quad \Gamma$

δ

$\delta(q_0, a, z_0) = (q_0, az_0)$
$\delta(q_0, b, z_0) = (q_0, bz_0)$
$\delta(q_0, a, a) = (q_0, aa)$
$\delta(q_0, b, b) = [q_0, bb)$

$\delta(q_0, a, b) = (q_0, \varepsilon)$
$\delta(q_0, b, a) = (q_0, \varepsilon)$
$\delta(q_0, \varepsilon, a) = (q_1, \varepsilon)$
$\delta(q_1, \varepsilon, a) = (q_1, \varepsilon)$
$\delta(q_1, \varepsilon, z_0) = (q_1, \varepsilon)$

(b) equivalent CFG all CFG constructed from PDA will be in GNF form. → (10 marks)

$CFG = (V, T, P, S)$ $\quad T = \{a, b\}$ $\quad S = S$

$V = \{S, [q_0 a q_0], [q_0 a q_1], [q_1 a q_0], [q_1 a q_1], [q_0 z_0 q_0], [q_0 z_0 q_1], [q_1 z_0 q_0], [q_1 z_0 q_1], [q_0 b z_0], [q_0 b q_1], [q_1 b q_0], [q_1 b q_1]\}$

Transition to production rules

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

$[q_0 z_0 q_0] \to a\,[q_0 a q_0]\,[q_0 z_0 q_0]$
$[q_0 z_0 q_0] \to a\,[q_0 a q_1]\,[q_1 z_0 q_0]$
$[q_0 z_0 q_1] \to a\,[q_0 a q_0]\,[q_0 z_0 q_1]$
$[q_0 z_0 q_1] \to a\,[q_0 a q_1]\,[q_1 z_0 q_1]$

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

$[q_0 a q_0] \to a\,[q_0 a q_0]\,[q_0 a q_0]$
$[q_0 a q_0] \to a\,[q_0 a q_1]\,[q_1 a q_0]$
$[q_0 a q_1] \to a\,[q_0 a q_0]\,[q_0 a q_1]$
$[q_0 a q_1] \to a\,[q_0 a q_1]\,[q_1 a q_1]$

$\delta(q_0, b, z_0) = (q_0, bz_0)$

$[q_0 b z_0 q_0] \to b\,[q_0 b q_0]\,[q_0 z_0 q_0]$
$[q_0 z_0 q_0] \to b\,[q_0 b q_1]\,[q_1 z_0 q_0]$
$[q_0 z_0 q_1] \to b\,[q_0 b q_0]\,[q_0 z_0 q_1]$
$[q_0 z_0 q_1] \to b\,[q_0 b q_1]\,[q_1 z_0 q_1]$

$\delta(q_0, b, b) = (q_0, bb)$

$[q_0 b q_0] \to b\,[q_0 b q_0]\,[q_0 b q_0]$
$[q_0 b q_0] \to b\,[q_0 b q_1]\,[q_1 b q_0]$
$[q_0 b q_1] \to b\,[q_0 b q_0]\,[q_0 b q_1]$
$[q_0 b q_1] \to b\,[q_0 b q_1]\,[q_1 b q_1]$

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

$[q_0 b q_0] \to a$

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

$[q_0 a q_0] \to b$

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

$[q_0 a q_0] \to \varepsilon$

$\delta(q_1, \varepsilon, a) = (q_1, \varepsilon)$

$[q_1 a q_1] \to \varepsilon$

$\delta(q_1, \varepsilon, z_0) = (q_1, \varepsilon)$

$[q_1 z_0 q_1] \to \varepsilon$

(c) V → variables T - terminals — 1 mark

(d) 2r + Σs production rules — 1 mark

4. Rainbow Toys

Case i: $R^m a^n V^{4n} y^{2m}$

Case ii: $R^n a^{3n}$

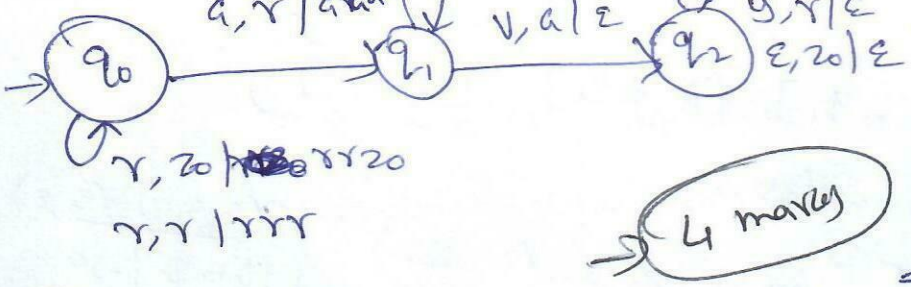
(a) option i, ii & iii

(b) True

(c) Case i: $L = \{R^m a^n V^{4n} y^{2m} \mid n \geq 1\}$

Case ii: $L = \{R^n a^{3n} \mid n \geq 1\}$ — 3 marks

(d) Case i:



4 marks

(e) i) tuple notation

PDA = {{q0, q1, q2}, {r, a, V, y}, {z0, r, a}, δ, q0, z0, ϕ}

Q, Σ, Γ

δ

δ(q0, r, z0) = (q0, rrz0)

δ(q0, r, r) = (q0, rr)

δ(q0, a, r) = (q1, aaaar)

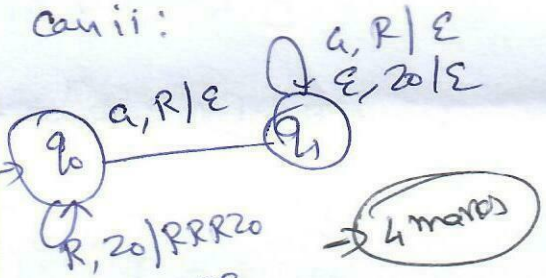
δ(q1, a, a) = (q1, aaaaa)

δ(q1, V, a) = (q2, ε)

⋮

2 marks

Case ii:



4 marks

ii) tuple notation

PDA = {{q0, q1}, {R, a}, {z0, R, a}, δ, q0, z0, ϕ}

Q, Σ, Γ

δ

δ(q0, R, z0) = (q0, RRRz0)

δ(q0, R, R) = (q0, RRRR)

δ(q0, a, R) = (q1, ε)

δ(q1, a, R) = (q1, ε)

δ(q1, ε, z0) = (q1, ε)

2 marks

(5) i/p $w = RRaaaa$

ID

$(q_0, RRaaaa, Z_0)$

$\vdash (q_0, Raaaa, RRZ_0)$

$\vdash (q_0, aaaa, RRRRZ_0)$

$\vdash (q_1, aaa, aaaaRRRRZ_0)$

$\vdash (q_1, aa, aaaaaaaaRRRRZ_0)$

$\vdash (q_1, a, aaaaaaaaaaaaRRRRZ_0)$

$\vdash (q_1, \varepsilon, aaaaaaaaaaaaaaaRRRRZ_0)$

$\vdash$ ✗ at end i/p stack not empty and transition not in final state.

→ i/p rejected.