IAT 2 SOLUTION Dec. 2024

Sub: Theory of Computation

Sub Code: BCS503

Ans 1 Input string $w = 0+((1*0)-1)$

LMD

$E \Rightarrow E+T$

$\Rightarrow T+T \quad (E \to T)$

$\Rightarrow F+T \quad (T \to F)$

$\Rightarrow 0+T \quad (F \to 0)$

$\Rightarrow 0+F \quad (T \to F)$

$\Rightarrow 0+(E) \quad (F \to (E))$

$\Rightarrow 0+(E-T) \quad (E \to E-T)$

$\Rightarrow 0+(T-T) \quad (E \to T)$

$\Rightarrow 0+(F-T) \quad (T \to F)$

$\Rightarrow 0+((E)-T) \quad (F \to (E))$

$\Rightarrow 0+((T)-T) \quad (E \to T)$

$\Rightarrow 0+((T*F)-T) \quad (T \to T*F)$

$\Rightarrow 0+((F*F)-T) \quad (T \to F)$

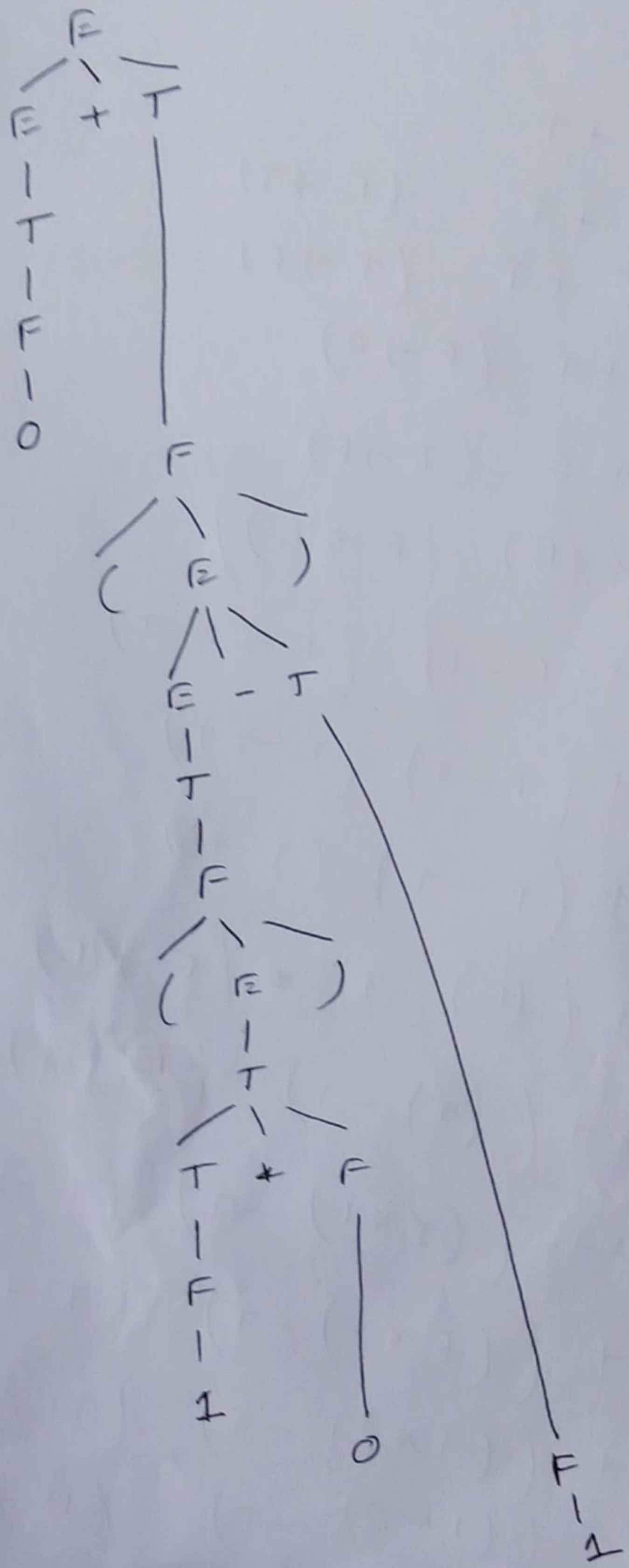
$\Rightarrow 0+((1*F)-T) \quad (F \to 1)$

$\Rightarrow 0+((1*0)-T) \quad (F \to 0)$

$\Rightarrow 0 + ((1*0) - F) \quad (T \rightarrow F)$

$\Rightarrow 0 + ((1*0) - 1) \quad (F \rightarrow 1)$

LMD Parse Tree



RMD

$E \Rightarrow E + T$

$\Rightarrow E + F \quad (T \to F)$

$\Rightarrow E + (E) \quad (F \to (E))$

$\Rightarrow E + (E - T) \quad (E \to E - T)$

$\Rightarrow E + (E - F) \quad (T \to F)$

$\Rightarrow E + (E - 1) \quad (F \to 1)$

$\Rightarrow E + (T - 1) \quad (E \to T)$

$\Rightarrow E + (F - 1) \quad (T \to F)$

$\Rightarrow E + ((E) - 1) \quad (F \to (E))$

$\Rightarrow E + ((T) - 1) \quad (E \to T)$

$\Rightarrow E + ((T * F) - 1) \quad (T \to T * F)$

$\Rightarrow E + ((T * 0) - 1) \quad (F \to 0)$

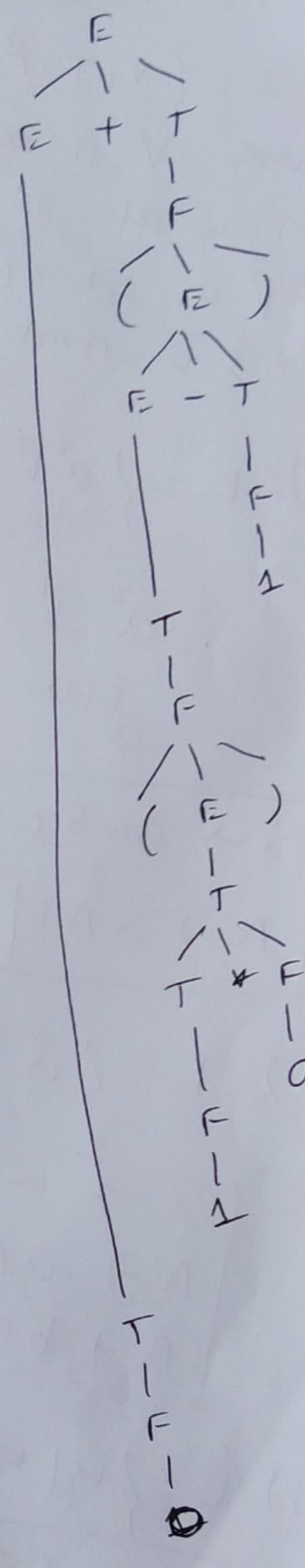
$\Rightarrow E + ((F * 0) - 1) \quad (T \to F)$

$\Rightarrow E + ((1 * 0) - 1) \quad (F \to 1)$

$\Rightarrow T + ((1 * 0) - 1) \quad (E \to T)$

$\Rightarrow F + ((1 * 0) - 1) \quad (T \to F)$

$\Rightarrow 1 + ((1 * 0) - 1) \quad (F \to 0)$



② CFG is defined by 4 tuples.

$G = (V, T, P, S)$

where V is set of Variables or Non terminals.

T is set of terminals

P is set of rules or productions

S is start symbol.

(i) $L = \{ a^i b^j c^k \mid i = j + 2k \text{ and } j, k \geq 1 \}$

$a^i b^j c^k$

$a^{j+2k} b^j c^k \Rightarrow a^{2k} a^j b^j c^k$

$$\boxed{\begin{array}{l} S \to aaSc \mid aaAc \\ A \to aAb \mid ab \end{array}}$$

(ii) $L = \{ a^m b^n \mid m \neq n, \text{ and } m, n \geq 1 \}$

$$\boxed{\begin{array}{l} S \to aSb \mid aAb \mid aBb \\ A \to aA \mid a \\ B \to bB \mid b \end{array}}$$

(iii) $L = \{ w \mid w \text{ contains balanced parenthesis} \}$

$$\boxed{S \to (S) \mid \{S\} \mid [S] \mid SS}$$

Ans 3. PDA is defined by 7-tuples

$M = (Q, \Sigma, \Gamma, \delta, q_0, Z_0, F)$

Where Q is a set of states

Σ is set of input symbols

Γ is stack symbols

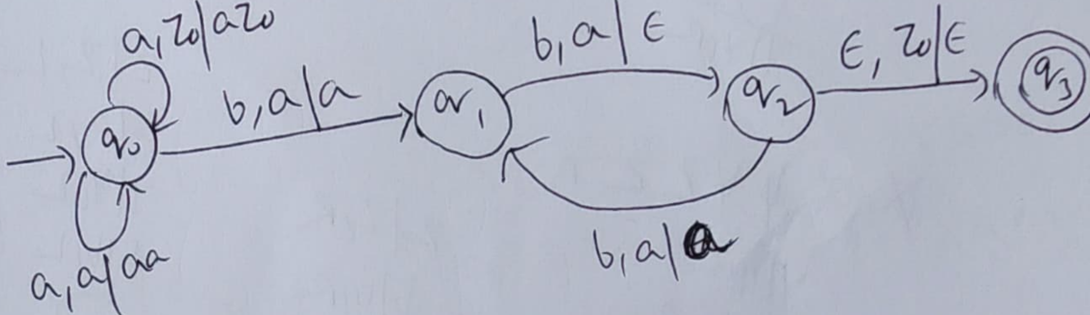
δ is transition function

q_0 is start state

Z_0 is initial stack symbol

F is final state.

PDA for $L = \{a^n b^{2n} \mid n \geq 1\}$



① $\delta(q_0, a, Z_0) = (q_0, aZ_0)$

② $\delta(q_0, a, a) = (q_0, aa)$

③ $\delta(q_0, b, a) = (q_1, a)$

④ $\delta(q_1, b, a) = (q_2, \epsilon)$

⑤ $\delta(q_2, b, a) = (q_1, a)$

⑥ $\delta(q_2, \epsilon, Z_0) = (q_3, \epsilon)$

$q_0, aaabbbbbb, Z_0 \vdash q_0, aabbbbbb, aZ_0 \vdash q_0, abbbbbb, aaZ_0$

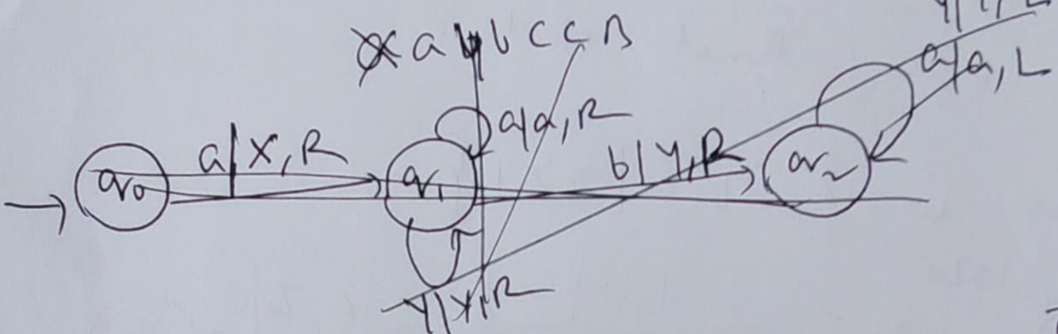
$\vdash q_0, bbbbbb, aaaZ_0 \vdash q_1, bbbbb, aaaZ_0$

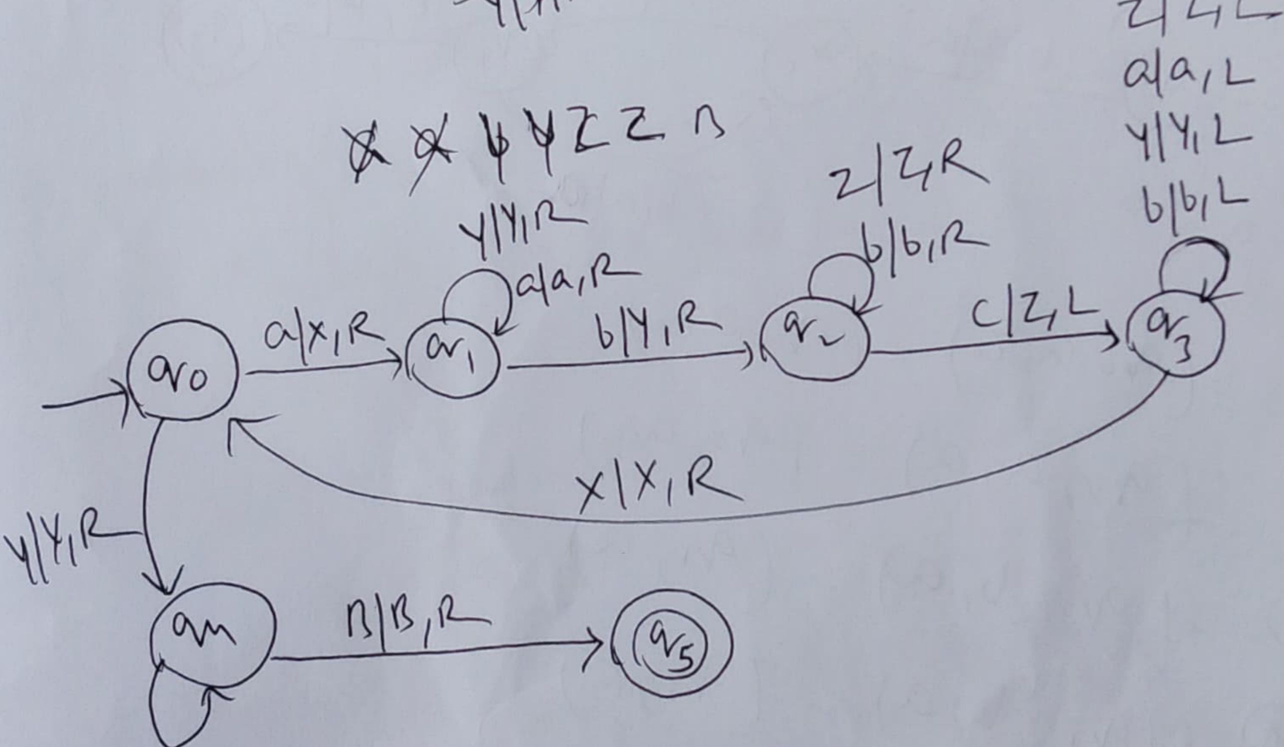
$\vdash q_2, bbbb, aaZ_0 \vdash q_1, bbb, aaZ_0$

$\vdash q_2, bb, aZ_0 \vdash q_1, b, aZ_0$

$\vdash q_2, \epsilon, Z_0 \vdash q_3, \epsilon, \epsilon$ Accepted

Ans 4 TM for $L = \{a^n b^n c^n \mid n \geq 1\}$





1. $\delta(q_0, a) = (q_1, X, R)$
2. $\delta(q_1, a) = (q_1, a, R)$
3. $\delta(q_1, Y) = (q_1, Y, R)$
4. $\delta(q_1, b) = (q_2, Y, R)$
5. $\delta(q_2, b) = (q_2, b, R)$
6. $\delta(q_2, Z) = (q_2, Z, R)$
7. $\delta(q_2, c) = (q_3, Z, L)$
8. $\delta(q_3, b) = (q_3, b, L)$
9. $\delta(q_3, Y) = (q_3, Y, L)$
10. $\delta(q_3, a) = (q_3, a, L)$
11. $\delta(q_3, Z) = (q_3, Z, L)$
12. $\delta(q_3, X) = (q_0, X, R)$
13. $\delta(q_0, Y) = (q_4, Y, R)$
14. $\delta(q_4, Y) = (q_4, Y, R)$
15. $\delta(q_4, Z) = (q_4, Z, R)$
16. $\delta(q_4, B) = (q_5, B, R)$

ID for aabbcc

$q_0aabbccB \vdash Xq_1abbccB \vdash Xaq_1bbccB$

$\vdash XaYq_2bccB \vdash XaYbq_2ccB \vdash XaYq_3bZcB$

$\vdash Xaq_3YbZcB \vdash Xq_3aYbZcB \vdash q_3XaYbZcB$

$\vdash Xq_0aYbZcB \vdash XXq_1YbZcB \vdash XXYq_1bZcB$

$\vdash XXYYq_2ZcB \vdash XXYYZq_2cB \vdash XXYYq_3ZZB$

$\vdash XXYq_3YZZB \vdash XXq_3YYZZB \vdash Xq_3XYYZZB$

$\vdash XXq_0YYZZB \vdash XXYq_4YZZB \vdash XXYYq_4ZZB$

$\vdash XXYYZq_4ZB \vdash XXYYZZq_4B \vdash XXYYZZBq_5$

Accepted

(5) (a) A grammar is in CNF, if the productions are in the following form.

$$\boxed{\begin{array}{l} A \to BC \\ A \to a \end{array}}$$

Conversion of CFG to CNF

Step 1 :

Null set = {B, D}

After removing NULL productions,

$S \to ABC \mid BaB \mid AC \mid Ba \mid aB \mid a$

$A \to aA \mid BaC \mid aaa \mid aC$

$B \to bBb \mid a \mid D \mid bb$

$C \to CA \mid AC$

Step 2 Removal of useless symbols

C, D are useless.

$S \to BaB \mid Ba \mid aB \mid a$

$A \to aA \mid aaa$

$B \to bBb \mid a \mid bb$

Now A is useless

$S \to BaB \mid Ba \mid aB \mid a$

$B \to bBb \mid a \mid bb$

Step 3 No Unit production.

Step 4 Convert to CNF

$S \to ZB \mid BX \mid XB \mid a$

$B \to PY \mid a \mid YY$

$X \to a$

$Y \to b$

$Z \to BX$

$P \to YB$

Ans 5. (b)

CFG to PDA

1. $\delta(q, \epsilon, E) = \{(q, E+T), (q, E-T), (q, T)\}$

2. $\delta(q, \epsilon, T) = \{(q, T*F), (q, F)\}$

3. $\delta(q, \epsilon, F) = \{(q, (E)), (q, 0), (q, 1)\}$

4. $\delta(q, +, +) = (q, \epsilon)$

10. $\delta(q, -, -) = (q, \epsilon)$

11. $\delta(q, *, *) = (q, \epsilon)$

(12) $\delta(q, (, () = (q, \epsilon)$

(13) $\delta(q,),)) = (q, \epsilon)$

(14) $\delta(q, 0, 0) = (q, \epsilon)$

(15) $\delta(q, 1, 1) = (q, \epsilon)$