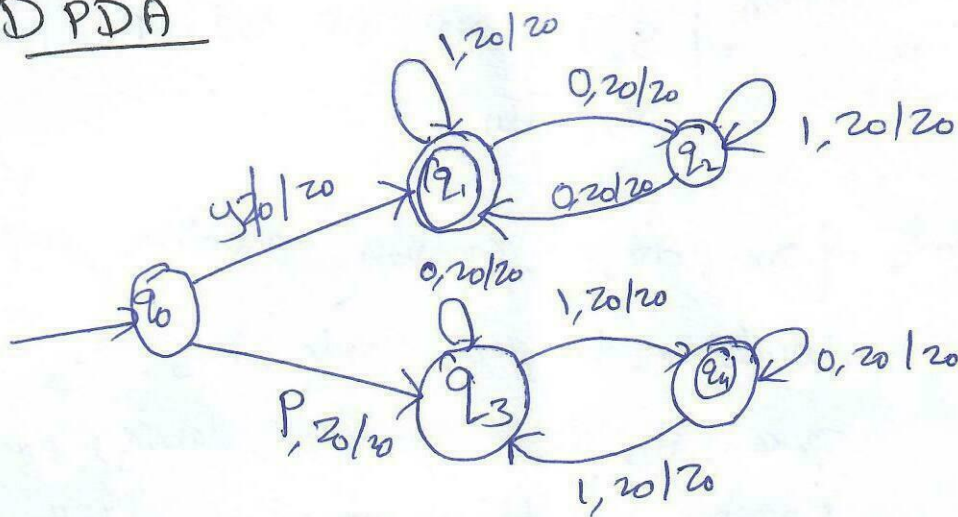


Answer key - 18CSC301T - FLA

① DPDA

i)

ii) ID "y0110010" $(q_0, y0110010, 20)$ 

↓

 $(q_0, 0110010, 20)$ 

↓

 $(q_2, 110010, 20)$ 

↓

 $(q_2, 10010, 20)$ 

↓

 $(q_2, 0010, 20)$ 

↓

 $(q_4, 010, 20)$ 

↓

 $(q_2, 10, 20)$ 

↓

 $(q_2, 0, 20)$ 

↓

 $(q_1, \epsilon, 20)$ 

end of ilp transition is in final state  
 State of ilp accepted.

ID "P1010" $(q_0, P1010, 20)$ 

↓

 $(q_3, 1010, 20)$ 

↓

 $(q_4, 010, 20)$ 

↓

 $(q_4, 10, 20)$ 

↓

 $(q_3, 0, 20)$ 

↓

 $(q_3, \epsilon, 20)$ 

end of ilp stack is not empty and transition is not in final state. ilp rejected.

② a) i. 32

①

①

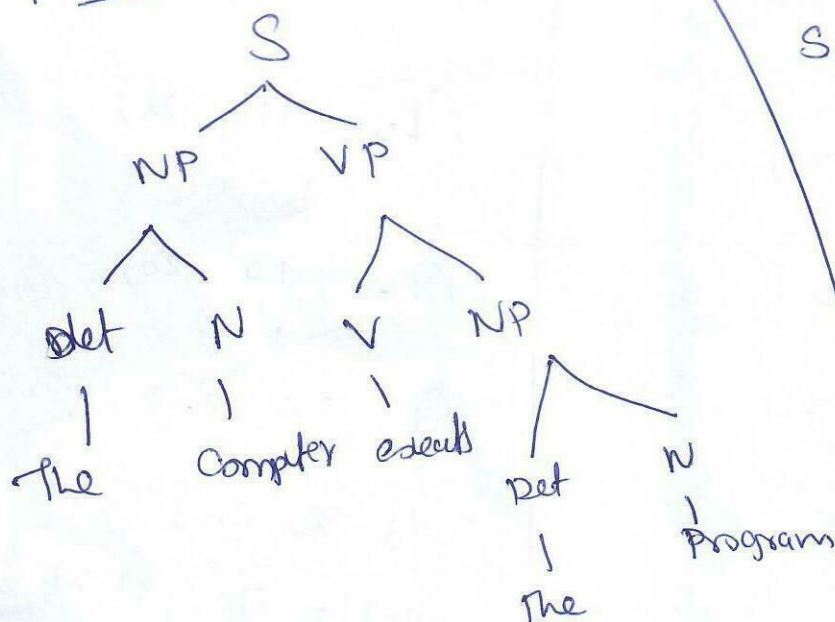
b) ii. Both Finite automata and push down automata

④ c) Non Terminals or variables =  $\left[ \begin{array}{l} S, NP, VP, PP, Det, N, Pronoun, \\ V, Adv, P \end{array} \right]$

Terminals = { the, an, a, computer, algorithm, program, data, developer, language, code, bug, I, you, he, she, it, write, compile, debug, execute, program, quickly, efficiently, carefully, in, which, for }

⑥ d) "the computer executes the program"

Parse Tree



derivation Left most

S → NP VP  
→ Det N VP  
→ the N VP  
→ the computer VP  
→ the computer V NP  
→ the computer executes NP  
→ the computer executes Det N  
→ the computer executes the N  
→ the computer executes the program



Bright most derivation

$S \rightarrow NP VP$   
 $S \rightarrow NP V NP$   
 $S \rightarrow NP V Det N$   
 $S \rightarrow NP V Det program$   
 $S \rightarrow NP V the program$   
 $S \rightarrow NP execute the program$   
 $S \rightarrow Det N execute the program.$   
 $S \rightarrow Det computer execute the program$   
 $S \rightarrow the computer execute the program.$

e. Simplification of grammar  
 No useless symbol & no  $\epsilon$  production  
 → Unit production [elimination] → 4 marks

$NP \rightarrow Det N \mid Det N PP \mid \underline{pronoun}$

$NP \rightarrow Det N \mid Det N PP \mid I \mid you \mid he \mid she \mid it$

$VP \rightarrow \underline{V} \mid V NP \mid V NP PP \mid VP Adv \mid VP Adv PP$

$VP \rightarrow write \mid compile \mid debug \mid execute \mid program \mid$   
 $V NP \mid V NP PP \mid VP Adv \mid VP Adv PP$

f) CNF

$NP \rightarrow \underline{Det} N PP$

$NP \rightarrow X_1 PP$

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

$VP \rightarrow X_2 PP \mid X_3 PP$

$X_3 \rightarrow VP Adv$   
 $X_1 \rightarrow Det N$   
 $X_2 \rightarrow V NP$

→ 4 marks

③ a. Lang Rep

$$L = \{r^n y^n w^n \mid n \geq 1\}$$

→ not context free grammar

(2 marks)

b. pumping lemma

1. Assume  $L$  is CFA

2. If  $L$  is CFA then

$$\exists w = uvxyz \in L$$

split  $\exists w = r^n y^n w^n$  into  $uvxyz$

$$\begin{array}{ccc} \frac{r \dots r^n}{r^{n-s}} & \frac{y \dots y^n}{y^n} & \frac{w \dots w^n}{w^{n-s}} \\ \frac{r^{n-s}}{u} & \frac{y^n}{x} & \frac{w^{n-s}}{z} \end{array} \in L$$

then  $uv^i x y^i z$  should  $\in L$

if  $i=2$

$$r^{n-s} (r^s)^2 y^n (w^{n-s})^2 w^{n-s}$$

$r^{n+s} y^n w^{n+s} \notin L$  Contradiction

Hence given lang is not context free lang.

c. CFA  $L = \{r^n y^{2n} \mid n \geq 1\}$

(4 marks)

$$\begin{array}{l} S \rightarrow r A y y \\ A \rightarrow r A y y \mid r y y \end{array}$$

$$(or) \begin{array}{l} S \rightarrow r A y y \\ A \rightarrow r A y y \mid r y y \end{array}$$



d. CNF 3 marks  
 → no unit, useless or  $\epsilon$  production

$$\begin{aligned} X_1 &\rightarrow r \\ X_2 &\rightarrow y \\ X_3 &\rightarrow X_1 A \\ X_4 &\rightarrow X_2 X_2 \end{aligned}$$

$$\begin{aligned} S &\rightarrow X_1 A X_2 X_2 \\ S &\rightarrow X_3 X_4 \\ A &\rightarrow X_3 X_4 \mid X_1 X_4 \end{aligned}$$

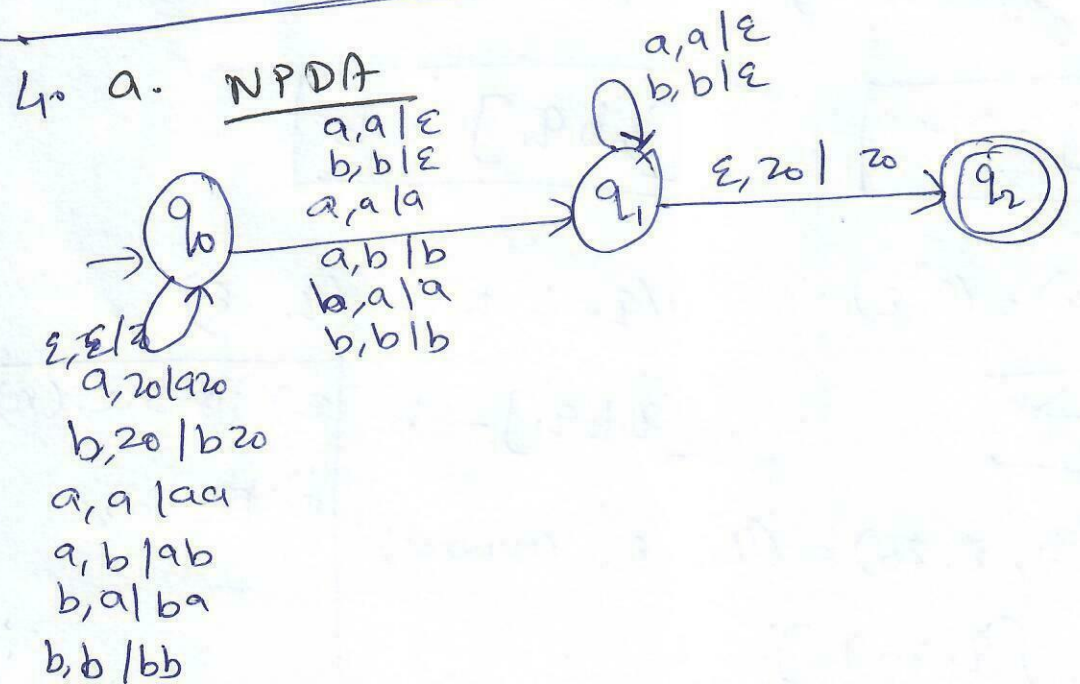
3 marks

GNF

$$\begin{aligned} X_1 &\rightarrow r \\ X_2 &\rightarrow y \\ X_3 &\rightarrow r A \\ X_4 &\rightarrow y X_2 \end{aligned}$$

$$\begin{aligned} S &\rightarrow r A X_4 \\ A &\rightarrow r A X_4 \mid r X_4 \end{aligned}$$

- e. i. DPDA  
 f. ii. Elimination of empty productions from a grammar



## b. Tuple notation & Transition function

$$PDA = (\{q_0, q_1, q_2\}, \{a, b\}, \{z_0, a\}, \delta, q_0, z_0, \{q_2\})$$

### $\delta$ function

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

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

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

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

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

$$\delta(q_0, \text{blank}, z_0) = (q_0, b z_0)$$

$$\delta(q_1, \epsilon, z_0) = (q_2, \epsilon)$$

$$\delta(q_0, a, a) = (q_1, \epsilon)$$

$$\delta(q_0, b, b) = (q_1, \epsilon)$$

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

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

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

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

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

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

c. ID for odd length of string

2 mark

even length of string

2 mark

d. pop operation conversion to production rules

$$\delta(q_0, a, a) = (q_1, \epsilon)$$

$$\delta(q_0, b, b) = (q_1, \epsilon)$$

6 marks

$$[q_0 a q_1] \rightarrow a$$

$$[q_0 b q_1] \rightarrow b$$

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

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

$$[q_1 a q_1] \rightarrow a$$

$$[q_1 b q_1] \rightarrow b$$

$$\delta(q_1, \epsilon, z_0) = (q_2, \epsilon) \text{ (optional)}$$

$$[q_1 z_0 q_2] \rightarrow \epsilon$$

e) i/p size (n)

f) ~~True~~ False