COMPUTER ENGINEERING DEPARTMENT

ASSIGNMENT NO-08

Sub: Theory of Computer Science

COURSE: T.E. Year: 2020-2021 Semester: V
DEPT: Computer Engineering
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Class: TE-Comps B Date of Submission: 23/11/2020

Tutorial 8

1. Design PDA for
   1] $L=\{a^{n-1} b^{2n+1} | n>=1\}$
   2] $L=\{a^{n} b^{m} a^{n} | m,n>=1\}$

2. Design a PDA to accept each of the following languages
   i. $\{0^n1^m0^n \mid m,n\geq 1\}$
   ii. $\{0^n1^m0^m 0^n \mid m,n\geq 1\}$

3. I] Design PDA to check even parenthesis over $\Sigma=\{0,1\}$
   II] Design DPDA for $L=\{ x | Na(x) > Nb(x)\}$

4. Generate Rule for the grammar
   $E \rightarrow E+E \mid E-E \mid (E) \mid id$

5. Give the application of PDA

Q.1 Design PDA for

① $L = \{ a^{n-1} b^{2n+1} \mid n \geq 1 \}$

Ans:

$G = \{ bbb, abbbbb, aabbbbbbb, \ldots\ldots \}$

Logic: For each a push two x into stack
For the first three b no operation (by pass)
For each b pop one x from stack

Machine is formally defined as

$M = \{ Q, \Sigma, \delta, \Gamma, q_0, z_0, F \}$

where,

$Q = \{ q_0, q_1, q_F \}$

$\Gamma = \{ x, z_0 \}$

$z_0 \rightarrow$ stack symbol

$q_0 \rightarrow$ Initial state

$F \rightarrow q_F$

Rule:

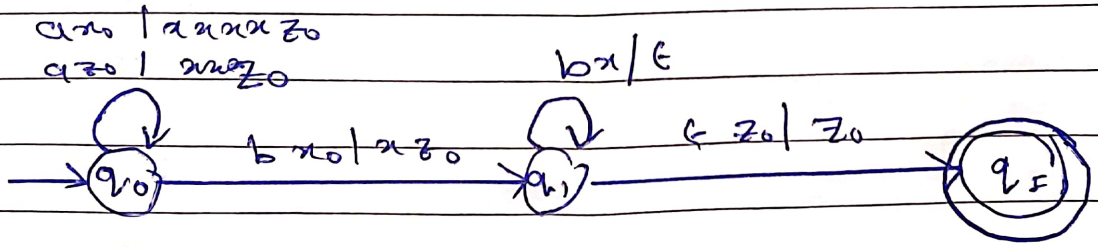
$\delta(q_0, a, z_0) = (q_0, xxz_0)$

$\delta(q_0, a, x) = (q_0, xxxxz_0)$

$\delta(q_0, b, x) = (q_1, xz_0)$

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

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



Simulation:

$\delta(q_0, aaabbbbbbbbb, Z_0)$

$\vdash (q_0, aabbbbbbbbb, XZ_0)$

$\vdash (q_0, abbbbbbbbb, XXZ_0)$

$\vdash (q_1, bbbbbbbbb, XXXZ_0)$

$\vdash (q_1, bbbbbbbb, XXXXZ_0)$

$\vdash (q_1, bbbbbbb, XXXXXZ_0)$

$\vdash (q_1, bbbbbb, XXXXXZ_0)$

$\vdash (q_1, bbbbb, XXXXXZ_0)$

$\vdash (q_1, bbbb, XXXXZ_0)$

$\vdash (q_1, bbb, XXXZ_0)$

$\vdash (q_1, bb, XXZ_0)$

$\vdash (q_1, b, XZ_0)$

$\vdash (q_1, \epsilon, Z_0)$

$\vdash (q_F, Z_0)$

Accept

(11) $L = \{ a^n b^m a^n \mid m, n >= 1 \}$

Ans.

Logic:

- For each a push 1x into the stack
- For b bypass all b's
- For each a pop 1x from the stack.

Machine definition:

Let $m = (Q, \Sigma, \Gamma, q_0, z_0, F)$

where,

$Q = \{ q_0, q_1, q_2, q_f \}$

$\Sigma = \{ a, b \}$

$\Gamma = \{ x, z_0 \}$

Rules:

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

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

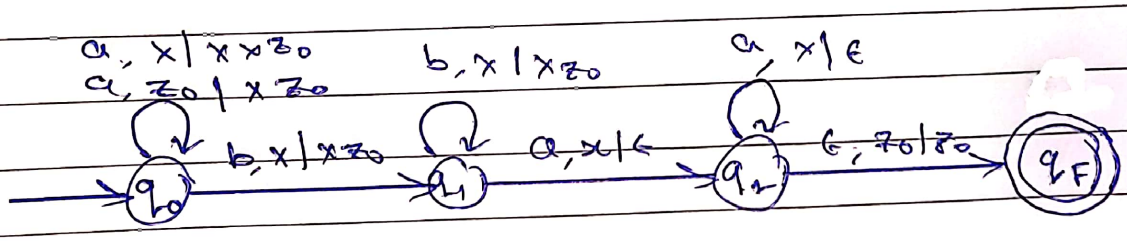
$\delta(q_0, b, x) = (q_1, x z_0)$

$\delta(q_1, b, x) = (q_1, x z_0)$

$\delta(q_1, a, x) = (q_2, \epsilon)$

$\delta(q_2, a, x) = (q_2, \epsilon)$

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



Simulation: $\delta(q_0, aba, z_0)$

$\vdash (q_0, ba, x z_0)$

$\vdash (q_1, a, x z_0)$

$\vdash (q_2, \epsilon, z_0)$

$\vdash (q_f, z_0)$

Accepted

Q.2. Design a PDA to accept

(1) $\{ 0^n 1^m 0^n \mid m, n \geq 1 \}$

Ans:

Logic:

For each 0 push 1 x into the stack
For 1 bypass all 1s.
For each 0 pop 1 x from the stack

Machine Definition:

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

where,

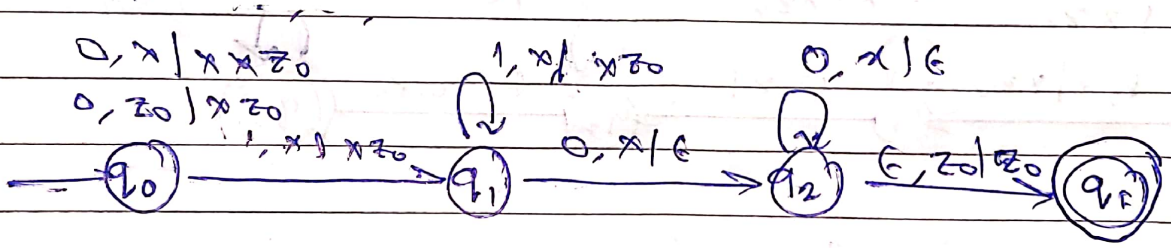
$Q = \{ q_0, q_1, q_2, q_F \}$

$\Sigma = \{ 0, 1 \}$

$\Gamma = \{ X, Z_0 \}$

Rule:

$\delta(q_0, 0, Z_0) = (q_0, X Z_0)$
$\delta(q_0, 0, X) = (q_0, XX Z_0)$
$\delta(q_0, 1, X) = (q_1, X Z_0)$
$\delta(q_1, 1, X) = (q_1, X Z_0)$
$\delta(q_1, 0, X) = (q_2, \epsilon)$
$\delta(q_2, 0, X) = (q_2, \epsilon)$
$\delta(q_2, \epsilon, Z_0) = (q_2, \epsilon)$



Simulation: $\delta(q_0, 010, Z_0)$
$\vdash (q_0, 10, X Z_0)$
$\vdash (q_1, 0, X Z_0)$
$\vdash (q_2, \epsilon, Z_0)$
$\vdash (q_F, Z_0)$

Accepted

(11) $\{0^n 1^m 0^n \mid m, n \geq 1\}$

Ans:

Logic:

For each leading 0 push 1X into the stack
For each 1 push 1X into the stack
Xs on the stack are matched with trailing 0s in the input, pop them.

Machine Definition.

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

where,

$Q = \{q_0, q_1, q_2, q_f\}$

$\Sigma = \{0, 1\}$

$\Gamma = \{X, Z_0\}$

Rule:

$\delta(q_0, 0, Z_0) = (q_0, XZ_0)$

$\delta(q_0, 0, X) = (q_0, XXZ_0)$

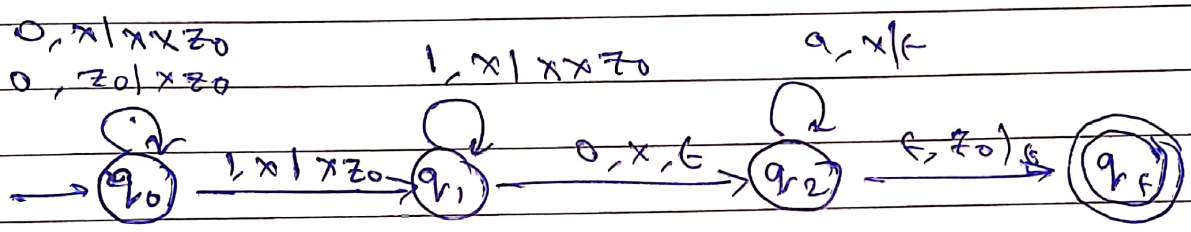
$\delta(q_0, 1, X) = (q_1, XZ_0)$

$\delta(q_1, 1, X) = (q_1, XXZ_0)$

$\delta(q_1, 0, X) = (q_2, \epsilon)$

$\delta(q_2, 0, X) = (q_2, \epsilon)$

$\delta(q_2, \epsilon, Z_0) = (q_f, G)$



Simulation: $\delta(q_0, 0100, Z_0)$

$\vdash (q_0, 100, XZ_0)$

$\vdash (q_1, 00, XXZ_0)$

$\vdash (q_2, 0, XZ_0)$

$\vdash (q_2, \epsilon Z_0)$

$\vdash (q_f, Z_0)$ Accepted

Q.3

① Design PDA to check even parentheses over $\Sigma = \{0, 1\}$

Ans:

Logic:

For input '(, [' push it into the stack

For every ')', ']', pop from the stack.

Machine definition

Let $m = (Q, \Sigma, \Gamma, \delta, q_0, z_0, F)$

where,

$Q = \{q_0, q_f\}$

$\Sigma = \{(, [,]\}$

$\Gamma = \{Z_0, (, [\}$

Rule:

$\delta(q_0, (, Z_0) = (q_0, (Z_0)$

$\delta(q_0, [, Z_0) = (q_0, [Z_0)$

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

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

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

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

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

$\delta(q_0,], [) = (q_0, \epsilon)$

$\delta(q_0, \epsilon, Z_0) = (q_f, Z_0)$

[, [| [[

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[, Z_0 | [Z_0

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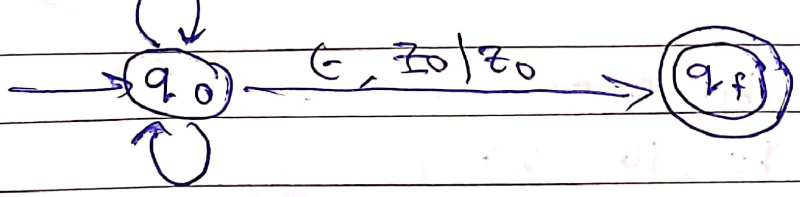


(, [| [(

[, (| [(

), (| ϵ

], [| ϵ

Simulation: $\delta(q_0, ([]), Z_0)$

$\vdash (q_0, [])), X Z_0)$

$\vdash (q_0,]), [Z_0)$

$\vdash (q_0,), Z_0)$

$\vdash (q_0, \epsilon, Z_0)$

$\vdash (q_f, Z_0)$

Accepted

(11) Design DPDA for $L = \{ x \mid N_a(x) > N_b(x) \}$

Ans.

Logic

For each 'a' push 1x into stack

For each 'b' pop 1x from stack

Pop x till stack is empty using null string

Machine definition

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

where,

$Q = \{ q_0, q_1, q_2, q_f \}$

$\Sigma = \{a, b\}$

$\Gamma = \{X, Z_0\}$

Rule:

$\delta(q_0, a, Z_0) = (q_0, XZ_0)$

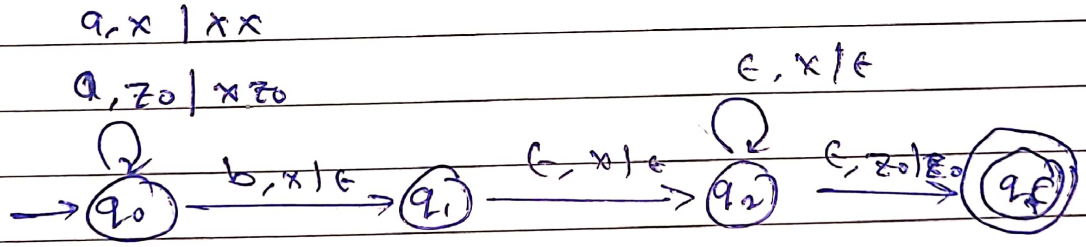
$\delta(q_0, a, X) = (q_0, XX)$

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

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

$\delta(q_2, \epsilon, X) = (q_2, \epsilon)$

$\delta(q_2, \epsilon, Z_0) = (q_f, Z_0)$



Simulation: $\delta(q_0, aab, Z_0)$

$\vdash (q_0, ab, XZ_0)$

$\vdash (q_0, b, XXZ_0)$

$\vdash (q_1, \epsilon, XZ_0)$

$\vdash (q_2, \epsilon, Z_0)$

$\vdash (q_f, Z_0)$

Accepted

Q.4. Generate Rule for Grammar

$E \rightarrow E+E \mid E-E \mid (E) \mid id$

Ans!

Rules :

$$\delta(q_0, \varepsilon, Z_0) = \{(q_1, \Sigma Z_0)\}$$
$$\delta(q_1, +, E) = \{(q_1, E)\}$$
$$\delta(q_1, -, E) = \{(q_1, E)\}$$
$$\delta(q_1, (, E) = \{(q_1, EA)\}$$
$$\delta(q_1, id, E) = \{(q_1, \varepsilon)\}$$
$$\delta(q_1,), A) = \{(q_1, \varepsilon)\}$$
$$\delta(q_1, \varepsilon, Z_0) = \{(q_f, Z_0)\}$$

Q.5. Give the application of PDA.

Ans:

Applications of PDA

- PDA is a machine for CFL.
- A string belonging to a CFL can be recognized by a PDA.
- PDA is extensively used for parsing.
- PDA is an abstract machine; it can also used for giving proofs of lemma on CFL.