SRMIST - School of Computing

Set D (1)

Answer key - 18CSC 301T - FLA

(1) CFG - parse Tree always binary - convert CFG - CNF → 7 marks

Stmt → IfStmt | printstmt

~~unlabeled~~ IfStmt → if (Expr) Stmt

printstmt → print (Expr)

Expr → ID | Num | Expr + Expr | Expr * Expr | (Expr)

→ no useless symbols and no ε transition

Elimination of unit production

Stmt → if (expr) Stmt | print (expr)

CNF

$X_1 \rightarrow$ if

$X_2 \rightarrow$ print

$X_3 \rightarrow$ (

$X_4 \rightarrow$)

$X_5 \rightarrow$ +

$X_6 \rightarrow$ *

$X_7 \rightarrow X_1 X_3$

$X_8 \rightarrow X_4$ Stmt

$X_9 \rightarrow X_7$ Expr

$X_{10} \rightarrow X_2 X_3$

$X_{11} \rightarrow$ Expr X_4

$X_{12} \rightarrow$ Expr X_5

$X_{13} \rightarrow$ Expr X_6

$X_{14} \rightarrow X_3$ Expr

IfStmt → if (Expr) Stmt

→ $X_1 X_3$ Expr X_4 Stmt

→ X_7 Expr X_4 Stmt

→ X_7 Expr X_8

IfStmt → $X_9 X_8$

printstmt → print (Expr)

→ $X_2 X_3$ Expr X_4

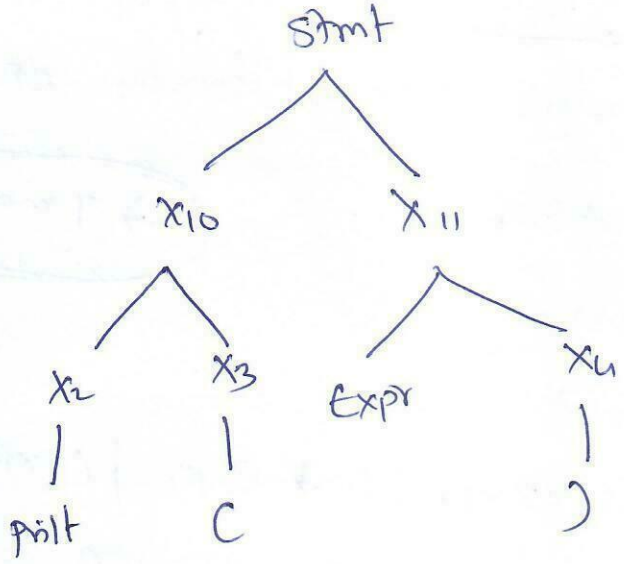
printstm → $X_{10} X_{11}$

Stmt → $X_9 X_8$ | $X_{10} X_{11}$

Expr → ID | Num | Expr X_5 Expr | Expr X_6 Expr | X_3 Expr X_4

Expr → ID | Num | X_{12} Expr | $X_{14} X_4$

Parse Tree — 3 marks



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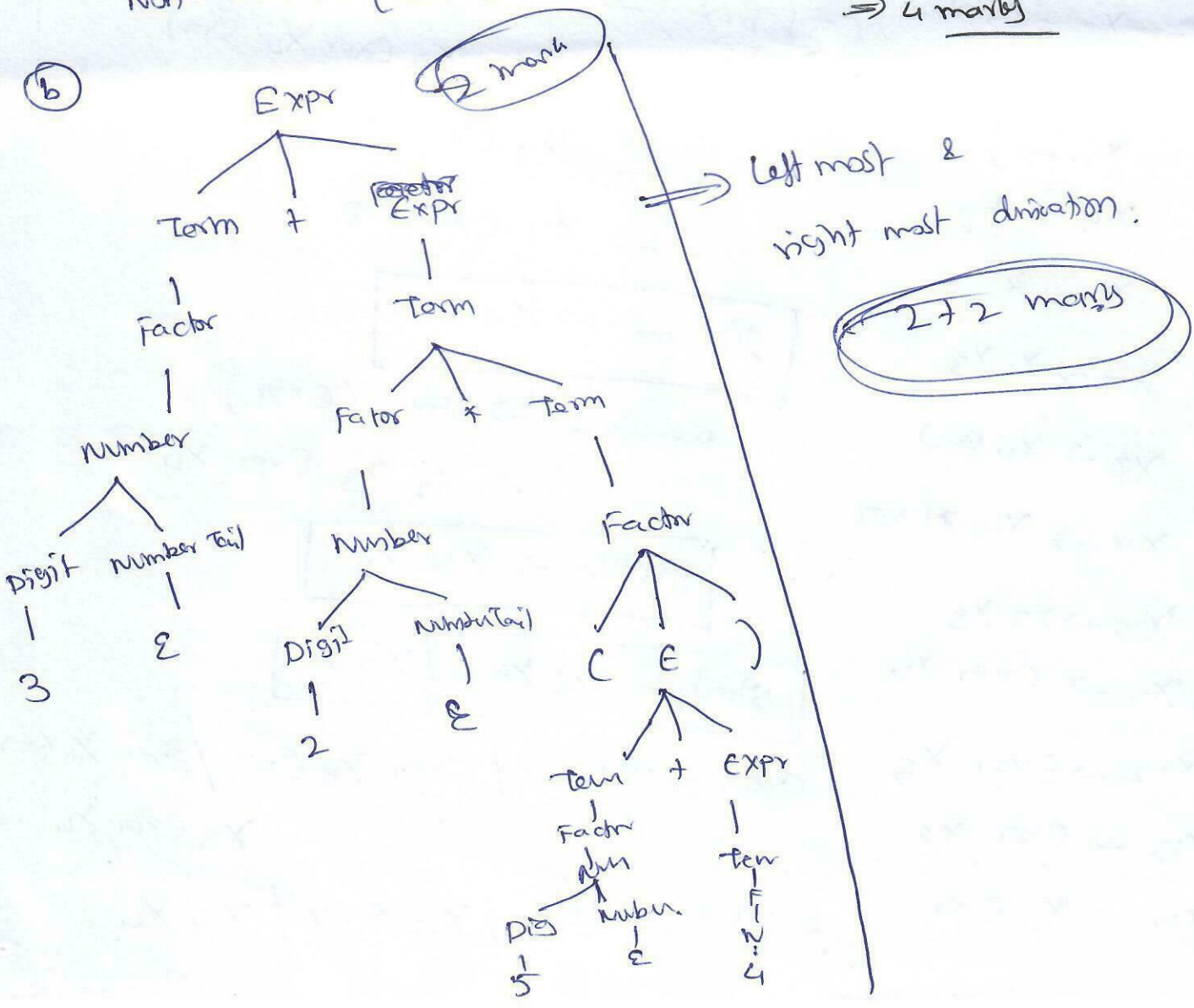
② CFG

ⓐ Terminals = { +, *, (,), 0, 1, 2, 3, 4, 5 ... 9 }

Non-Terminal = { Expr, Term, Factor, Number, NumberTail, Digit }

⇒ 4 marks

ⓑ



→ Left most & right most drivation.

2 + 2 marks

(c) simplification → 5 marks

⇒ no useless symbols

ε - production ⇒ NumberTail → Digit NumberTail | ε

elimination

NumberTail → Digit NumberTail | Digit

Number → Digit NumberTail | Digit

unit production elimination

~~Expr~~ number → Digit numberTail | 0 | 1 | 2 . . . | 9

number → Digit numberTail | 0 | 1 | 2 . . . . | 9

Factor → Digit numberTail | 0 | 1 | 2 . . . | 9 | (E)

Term → Factor * Term | Digit numberTail | 0 | 1 . . . | 9 | (E)

Expr → Term + Expr | Factor * Term | Digit numberTail | 0 | 1 | 2 . . | 9 | (E)

(d) Conversion to CNF

$X_1 \rightarrow ($

$X_2 \rightarrow)$

$X_3 \rightarrow X_1 E$

$X_4 \rightarrow +$

$X_5 \rightarrow *$

$X_6 \rightarrow$ Factor X_5

Factor → (E)

Factor → $X_1 E X_2$

Factor → $X_3 X_2$

Term → Factor * Term

Term → Factor X_5 Term

Term → X_6 Term

Expr → Term + Expr

Expr → Term X_4 Expr

$X_7 \rightarrow$ Term X_4

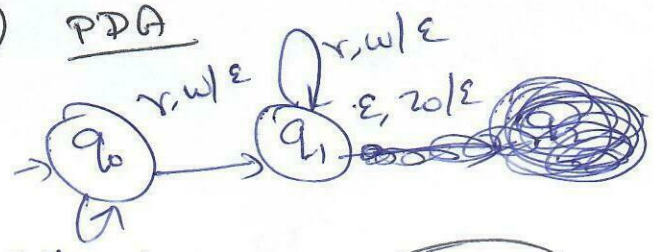
Expr → X_7 Expr

(3) $L\{\omega^n r^n \mid n \geq 0\}$

(a) n = finite ⇒ Finite Automata — 1 mark

(b) n = infinite ⇒ Push down automata — 1 mark

(c) PDA



4 marks

Tuple notation

$PDA = \{\{q_0, q_1, q_2\}, \{\omega, r\}, \{z_0, \omega\}, \delta, q_0, z_0, \{q_2\}\}$

$\delta(q_0, \omega, z_0) = (q_0 \omega z_0)$ — 2 marks

⋮

all transitions

an example + ID for it ⇒ 2 marks

(d) GNF PDA to CFG $[V, T, P, S]$ $S = S$, $T = \{\omega, r\}$ — 8 marks

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

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

$[q_0 z_0 q_0] \to \omega [q_0 \omega q_0] [q_0 z_0 q_0]$

$[q_0 z_0 q_0] \to \omega [q_0 \omega q_1] [q_1 z_0 q_0]$

$[q_0 z_0 q_1] \to \omega [q_0 \omega q_0] [q_0 z_0 q_1]$

$[q_0 z_0 q_1] \to \omega [q_0 \omega q_1] [q_1 z_0 q_1]$

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

$[q_0 \omega q_0] \to \omega [q_0 \omega q_0] [q_0 \omega q_0]$

$[q_0 \omega q_0] \to \omega [q_0 \omega q_1] [q_1 \omega q_0]$

$[q_0 \omega q_1] \to \omega [q_0 \omega q_0] [q_0 \omega q_1]$

$[q_0 \omega q_1] \to \omega [q_0 \omega q_1] [q_1 \omega q_1]$

$\delta(q_0, r, \omega) = (q_1, \varepsilon)$

$[q_0 \omega q_1] \to r$

$\delta(q_1, r, \omega) = (q_1, \varepsilon)$

$[q_1 \omega q_1] \to r$

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

$[q_1 z_0 q_1] \to \varepsilon$

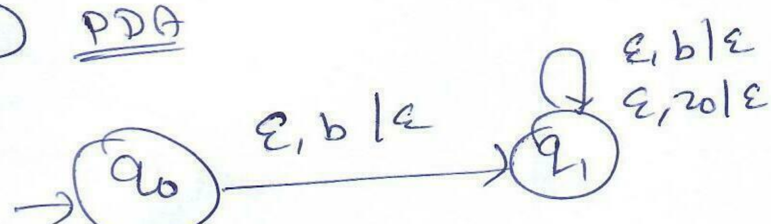
(e) NO. NPDA is more powerful than deterministic PDA. few problems can be solved only by NPDA not by DPDA. — 2 marks

④ blue balls > red balls

ⓐ size of blue balls + 1 — 1 mark

ⓑ No False its CFG — 1 mark

ⓒ PDA



b, z0 | b z0
b, b | b b
r, z0 | r z0
r, r | r r
b, r | ε
r, b | ε

— 4 marks

ⓔ $(q_0, bbbrrr, z_0)$
↓
$(q_0, bbrrr, bz_0)$
↓
$(q_0, brrr, bbz_0)$
↓
$(q_0, rrr, bbbz_0)$
↓
(q_0, rr, bbz_0)
↓
(q_0, r, bz_0)
↓
(q_0, ε, z_0)
↓
not accepted

4 marks

ⓓ Tuple notation

$PDA = \{\{q_0, q_1\}, \{b, r\}, \{z_0, b, r\}, \delta, q_0, z_0, \phi\}$ (Q, Σ, Γ)

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

→ all transition — 4 marks

ⓕ push operation

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

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

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

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

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

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

$[q_0 b q_0] \to b [q_0 b q_0] [q_0 b q_0]$

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

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

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

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

$[q_0 r q_0] \rightarrow r [q_0 r q_0] [q_0 r q_0]$

$[q_0 r q_0] \rightarrow r [q_0 r q_1] [q_1 r q_0]$

$[q_0 r q_1] \rightarrow r [q_0 r q_0] [q_0 r q_1]$

$[q_0 r q_1] \rightarrow r [q_0 r q_1] [q_1 r q_1]$

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

$[q_0 z_0 q_0] \rightarrow r [q_0 r q_1] [q_1 z_0 q_0]$

$[q_0 z_0 q_0] \rightarrow r [q_0 r q_0] [q_0 z_0 q_0]$

$[q_0 z_0 q_1] \rightarrow r [q_0 r q_0] [q_0 z_0 q_1]$

$[q_0 z_0 q_1] \rightarrow r [q_0 r q_1] [q_1 z_0 q_1]$

6 marks

— X —