Kalpana Bahile 310616104046 ese-111 - A

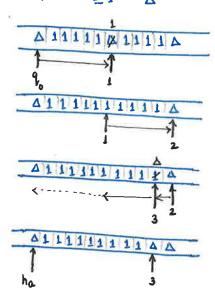
THEORY OF COMPUTATION OSSIGNMENT-3

) ADDITION

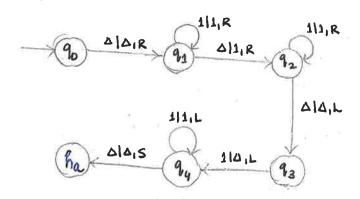
TAPE DIAGRAM :

Input: \$12 \$14 \$

Dulput: \$12+4 \$



TRANSITION DIAGRAM 6:



and hence:

T = ({90,...,149, {13, {13, 8, 90}}

NOTE :

- 1) ALL NUMBERS CONSIDERED FOR THE FOLLOWING ARITHMATIC OPERATIONS ARE POSITIVE NUMBERS.
- 2) FOR EVERY TURING MACHINE ILLUSTRATED, A SAMPLE STRING IS RUN ON THE RIGHT HAND COLUMN HERE.

ADDITION ~

RUN FOR $W = ^{\land}\Delta 111\Delta 1111\Delta^{\dagger}$ $(q_0, \Delta 111\Delta 1111\Delta) \vdash_{T}$ $(q_1, \Delta 111\Delta 1111\Delta) \vdash_{T}$ $(q_1, \Delta 111\Delta 1111\Delta) \vdash_{T}$ $(q_2, \Delta 11111111\Delta) \vdash_{T}$ $(q_2, \Delta 11111111\Delta) \vdash_{T}$ $(q_3, \Delta 11111111\Delta) \vdash_{T}$ $(q_4, \Delta 1111111\Delta) \vdash_{T}$ $(q_4, \Delta 1111111\Delta) \vdash_{T}$ $(q_4, \Delta 1111111\Delta) \vdash_{T}$ $(q_4, \Delta 1111111\Delta) \vdash_{T}$

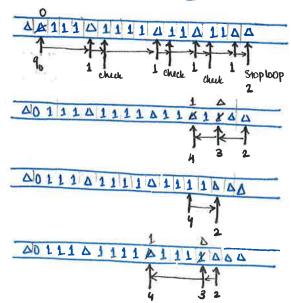
Extension (Not Compulsory):

ADDITION OF MULTIPLE NUMBERS:

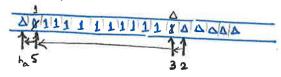
TAPE DIAGRAM:

Input: $\Delta 1^{a} \Delta 1^{b} \Delta 1^{c} \Delta ... \Delta 1^{n} \Delta$

Dulput: <u>\$\Delta 1 a+b+c+...+n</u>

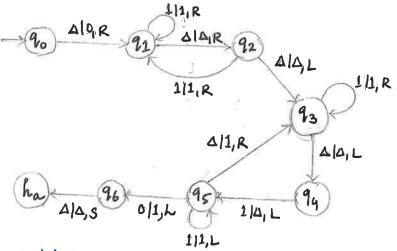


After few such sounds:



1 ha

TRANSITION DIAGRAM S:



and hence:

T = ({ 90,..., 963, 713, 20, 13, 8, 90)

ADDITION 2~

RUN FOR $W = \Delta 111 \Delta 11 \Delta 11 \Delta'$ (90, \$111 \$11 \$11 \$1) F (94,011) A12 A11A) (91,0111 \$ 11 A116) ++ (92, 0111 D11 D11 D) -(91, 0111 D11 1111)+ (32, 0111 4114114)+ (2, 01110110110) + (91, 0111 4114114) (91, 0111 D110114) + (92, 0111 D110 110 1) +T (93,011101101100)+ (94, 0111 011011 A) H (95,0111011010) (90,01120120100) -(93, 0111 A12 11 OA) (9g, 0112 0111101) -(94, 0111 01111 DA) H

(95, 01110111120)

(95, 0111 1 111100)1

(13, 01211 11110A); 193, 0122 1 1222A);

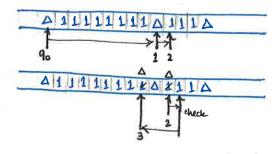
(94, 0121 1 1111 AD) +

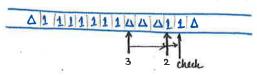
(95, 0111 1111 000)

2) SUBTRACTION

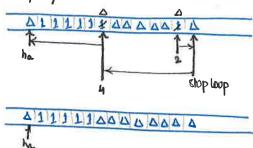
TAPE DIAGRAM!

Input: $\triangle 1^{2} \triangle 1^{3} \triangle$ where $2 \ge y$ Output: $\triangle 1^{2} \cdot y$

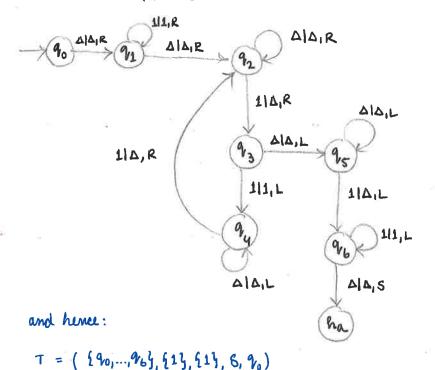




After few such nounds:



TRANSITION DIAGRAM 8:

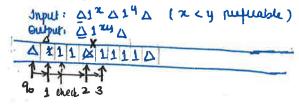


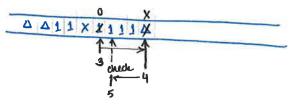
SUBTRACTION ~ RUN FOR W = ' D1111 D11 b' (90, DIILI DII D) + (91, DITIDITA) + (92, A1111 A11 A) (92, D1111 D11 D) -(93, A1111 AALA) -(934, D11111 D111) 1x (94, D1111 DD10) + (92, A1110 AL1 A) (92, D111 DDD 1 D) + (93, D11100000) (95, DIST DODD) + (95, D111 DDDDD) -(96, D11 DDDDD) 1+ (96, A11 DDDDDD) -

(ha, \$11 DDD DDD).

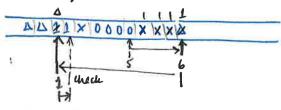
3) MULTIPLICATION

TAPE DIAGRAM:

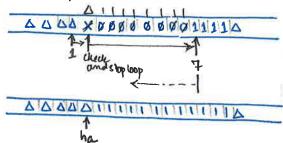




After a few counds:



In the final nound:



EXPLANATION:

1) READ A 1 on the x side, change to D, check next:

(a) IF MXt = 1:

ship all 1's and x's, if Δ comes, change Δ to X and go to the 1s of y side. (either after X or after 0's). Change 1 to 0, more right ship 1x hil Δ , change Δ to X, go back to next 1. Commune his all 1s are 0's and. Then immediately X's start. Change all X's to 1x. Go left, teacure all 0's, Teacure X, Teacure 1's, go to Δ and then right. REPERT 1.

More light, change all 0's to 1s. when you wach the 1's, turn left, Teaure all the 1's that were reunity ereated until you erach x, change x to D and STOP.

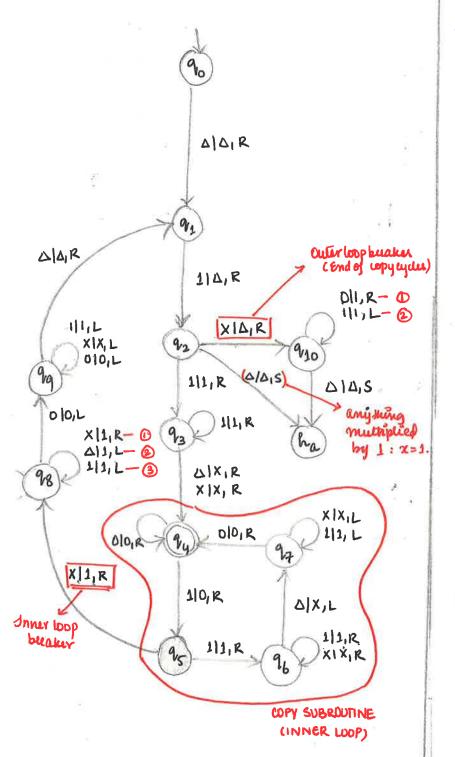
MULTIPLICATION ~

RUN FOR

W = ' \$11 \$1111 A'

190, <u>111011110</u>) + (91, Δ11 Δ1111Δ) +T (92, DD1 D1111D) +T (93, 00101111 A) +T 194, DD1 × 1111 D) FT (45, 011×01114) + (16, DUIX 0111D) 196, DOIXOLLIA) TT (94, 04 1 × 011 1XA) 190, 661×0111×6) + 194, 001×0111Xb) + (95, DOIX OULIXA) (96, WA1 × 0011XA) +* (96, DL1 X 00 11XA) (94, DD1X0011 XX A) + + (97, DOIX OD 11 XXA) -(94, DAIXOO11XXA) HT (95, DD1 × 0001 × XD) -(96, DD1 × 0001 XX 0) ++ 196, DUIX 0001 XX D) FT (91, 001 x 0001 XXX 6) (94, DU1 X 0001 XXXA) (94, DA1 × 0001 ××× b) ++ (9c, DD1x 0000 xxx D) 1-(98, DAIX 0000 1 XX A) (98, DA1 x 0000 1111 A) (99, DD1x000011110) 1-4 (94, ALIX 0000 1111 A) -

TRANSITION DIAGRAM 8:



and hence:

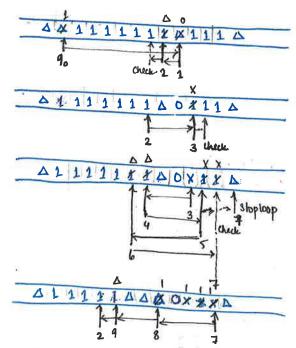
T = ({90,..., 920}, {14, 60,1, x3, 8, 90)

 $(9_{11} \triangle \Delta 1 \times 0000 1111)$ \vdash_{T} $(9_{10}, \triangle \Delta \Delta \times 0000 1111)$ \vdash_{T} $(9_{10}, \triangle \Delta \Delta \Delta 0000 1111)$ \vdash_{T} $(9_{10}, \triangle \Delta \Delta \Delta 11111111\Delta)$ \vdash_{T} $(h_{01}, \Delta 11111111\Delta)$

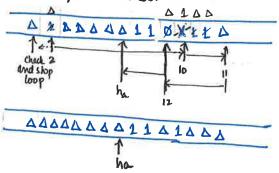
TAPE DIAGRAM:

Input: Δ12 Δ14 Δ (x,y>0)

Output: Δ1214 Δ1 x404 Λ



In the final wound:



EXPLANATION:

1) Change first Δ to 1, go to right till Δ . Change Δ to 0, go left, change last 1 to Δ .

2) Read A 1 after 0 and change to x, Check next:

(a) If next = 1: go lyt part 0 and partall 15 and a's till dicident part is and change 1 to a. If nextonless is 1 repeat(2), the go to (3).

(b) IF ment = Δ : go left changing all X's to 1's, go pasto, change the first Δ after 0 to 0.1, go past ot to dividend part 1's and change 1 to Δ . If ment on left is 1 repeat (2) , else go to (3).

3) Go park all sic, is and 0's, change all is to is and the 1's after that to s. Come back to o. Change 0 to s. come lyc park all the 1's and halt at s.

4) STOP.

DIVISION ~

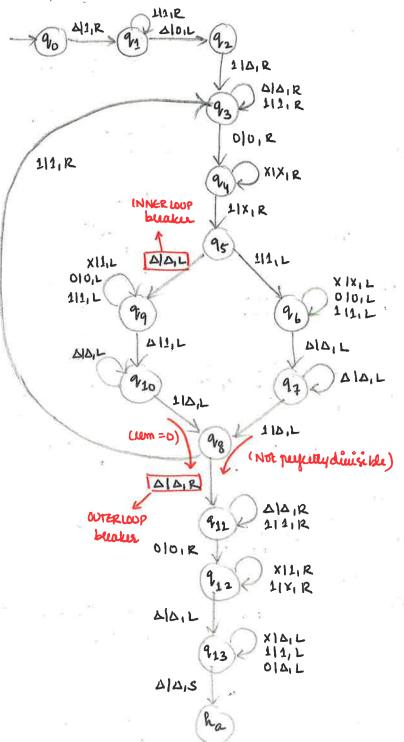
RUN FOR

W = ' \$\D111 \$\D1111 \D'

190, 4111011110) (91, D1111 41111D) + 191, D1111 A1111A) -(92, 41111011116) + (93, A111 A D11111 A) (94, A111 A0 1111A) + (95, \$11140×1114) + (96, A111 AOX 1111 A) +* (96, \$1112 0×111 6) F (97, 111 DOX 111 D) (98, A11 A D O X 111 A) + (93, 111 \$\DOX1114) = 173, A11AA OX121A) + (99, 411 AD X 111 A) + (94, D11 DD0 X1116)+ (9r, Δ11 Δδ 0 X X 11 Δ) +T (96, A)1 (NOXX 11 A) +T (96, 41180xx124) + (97, \$\Delta 11 \Delta \Delta \times \tau 12 \Delta) | \frac{*}{+} 197, 011 000XX116) (98, 01000X114) +T (93, DIADDOXX116) (93, 01000 XX 11 D) +T (94, 11 DALLOX X11 D) +*

(94, 01 DDDOXX120) =

TRANSITION DIAYRAM 6:



and hence:

T = (940,..., 9,33, 813, 80,1,×3, 8, 90)

(95, D1 DD DXXXI D) FT

(96, D1 DDD OXXXI D) FT

(96, D1 DDD OXXXI D) FT

(97, D1 DD DXXXI D) FT

(97, D1 DDD XXXI D) FT

(98, DD DDD XXXI D) FT

(911, DD DDD XXXI D) FT

(911, DD DDD XXXI D) FT

(912, DDD DD XXXI D) FT

(912, DDD DD XXXI D) FT

(913, DDD DD DXXXI D) FT

(914, DDD DXXXI D) FT

(915, DDD DXXXI D) FT

(916, DDD DXXXI D) FT

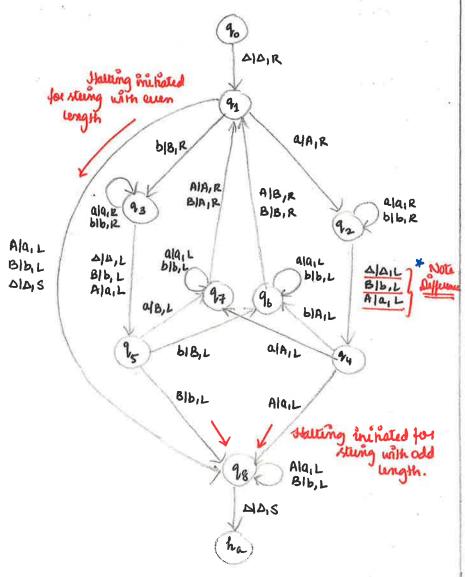
(917, DDD DXXXI D) FT

(918, DDD DXXI DDD DXXXI D) FT

(919, DDD DXXXI DDD DXXXI D) FT

5) STRING REVERSAL (SETTER SOLUTION)

TRANSITION DIAGRAM 8:



And hence:

T = ({ 90,..., 98, 3, 89, 64, 63, 80, A, 83, 8, 90)

NOTE 1: In ease of odd length strings, at state 94/95, the finite state control will encounter a capital letter while moving lose, meaning the middle is reached.

Whereas in even length string (including IWI = 0), the finite state control encounters a capital letter moving to the eight from 91, hence the loop becaking conditions are as stated above in the diagram.

NOTE 2: The difference * in BIb, L and Ala, L is that when the capital letters are changed to small then and there and then the conteol moves to left, the control needers go all the way to light end to toggle encephing back. It can start from wherelver its current position is hence movement & minimuled.

STRING REVERSAL W

) ODD LENGTH RUN FOR $W = ' \underline{A} ababb \underline{A}'$

(90, Dab abbas) +T (91, Dababbs) + (92, DAB abb D) +T (92, ∆A babb △) + (94, A Ababba) -(96, DA babas) +* (96, DA babAD) +T (91, ABB ab A A) +T (92, ABBABAD) HT (92, ABBabAA) + 194, DBB abab) + (96, ABB aBas) FT (96, UBBaBab) F (91, DBB aBab) -(92, ABBA Bas) 1-(94, ABBABAA) -(98, A BB aba s) 198, Abbabas) + (ha, Dbbabas)

2) EVEN LENGTH RUN FOR W = 'Ababba'

(90, ≥babbs) ++ (91, ababbb) + 193, sbabb s) +* (93, A Babb A) + (95, AB abba) -(96, ABabBD) 1 + (PL, ABabBA) ++ (11, A BabBa) + (92, DBABBA) + (92, A BALBA) (T (24, ABAbba) + (46, DBAADA) IT (91, ABBA 64) 1-(98, DBBabb) + (98, 0 bbab A) +T (har Dbbab A)