19/10/23

Assignment No. 5

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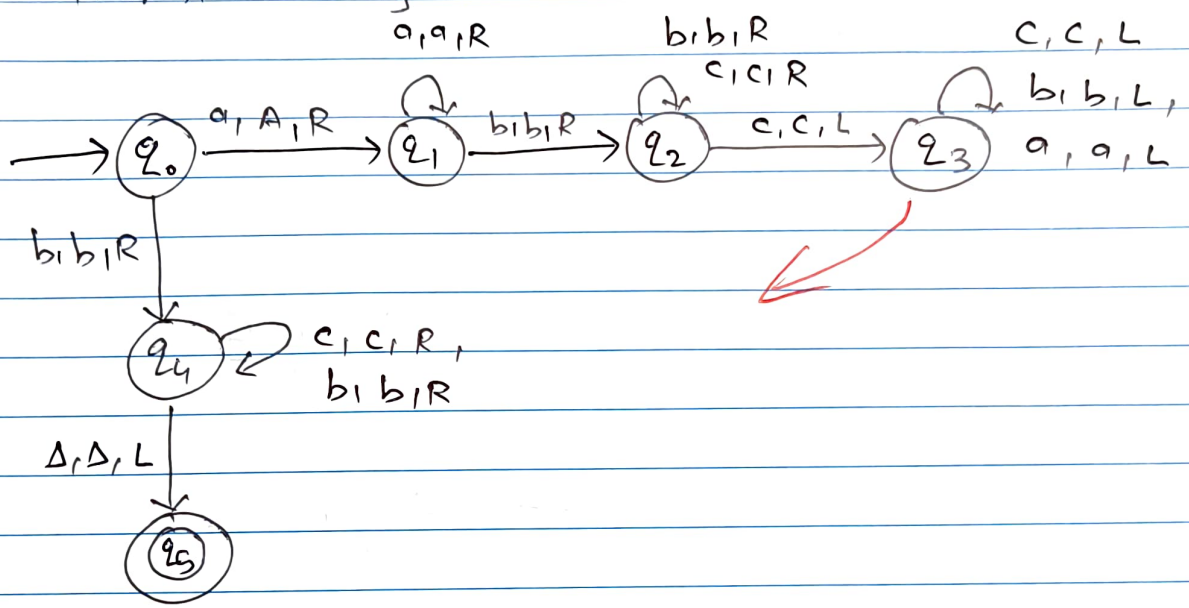
TE C32
2103163

Q.1 Design Turing Machine for recognizing the following language

$L = \{ a^n b^m c^n \mid m, n >= 1 \}$

⇒ Soln :-

- Transition diagram :



- Transition table :

	a	b	c	A	C	Δ
q_0	$\{q_1, A, R\}$	$\{q_4, b, R\}$				
q_1	$\{q_1, a, R\}$	$\{q_2, b, R\}$				
q_2		$\{q_2, b, R\}$	$\{q_2, c, L\}$		$\{q_2, c, R\}$	
q_3	$\{q_3, a, L\}$	$\{q_3, b, L\}$		$\{q_0, A, R\}$	$\{q_3, c, L\}$	
q_4		$\{q_2, b, R\}$			$\{q_4, c, R\}$	$\{q_5, a, L\}$
q_5						

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

$= (\{q_0, q_1, q_2, q_3, q_4, q_5\}, q_0, \{q_5\}, \{a, b, c\}, \{a, b, c, A, C\}, \delta, \Delta)$.

- Simulation :

a a b c c
↑
q_0

$\vdash$ A a b c c
↑
q_1

$\vdash$ A a b C c
↑
q_3

$\vdash$ A a b C c
↑
q_3

$\vdash$ A A b C c
↑
q_2

$\vdash$ A A b C C
↑
q_3

$\vdash$ A A b C C
↑
q_3

$\vdash$ A A b C C
↑
q_1

$\vdash$ A A b C C
↑
q_4

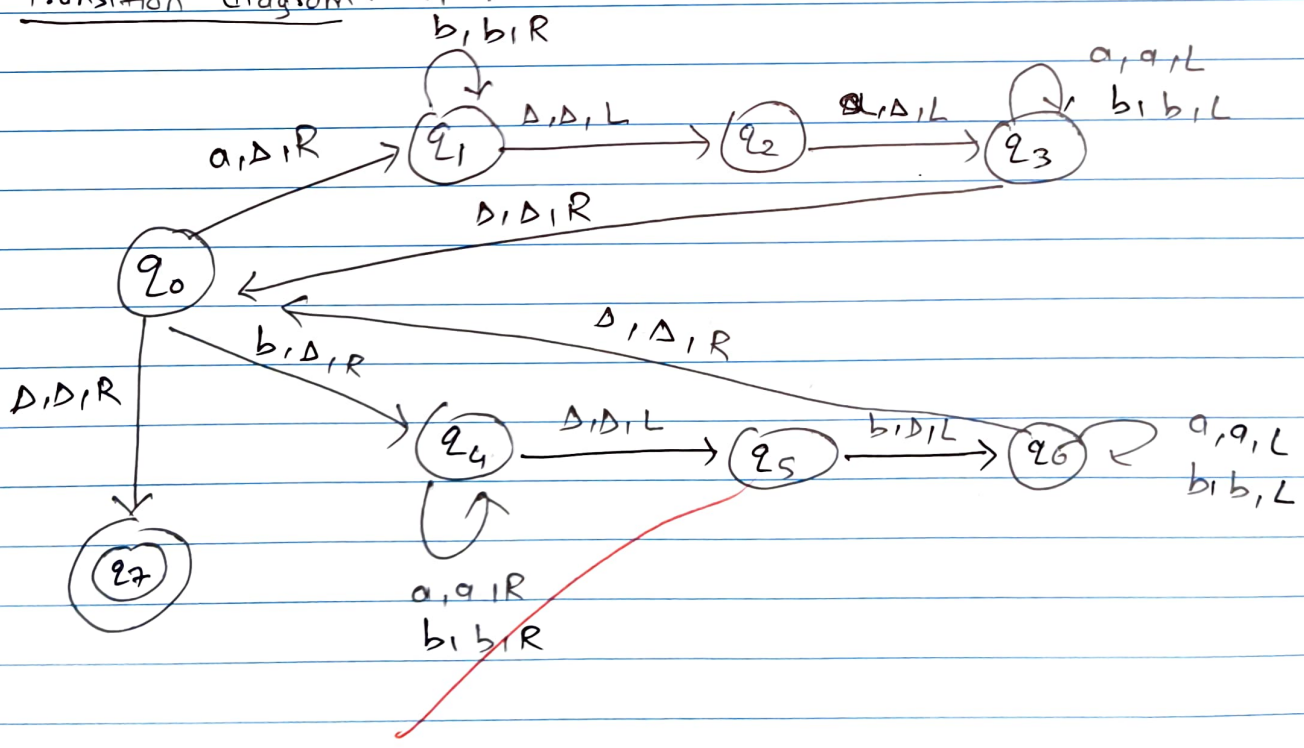
$\vdash$ A A b c c Δ
↑
q_4
$\vdash$ A A b C C Δ
↑
q_4
$\vdash$ A A b CC Δ
↑
q_5

∴ I/P string is accepted.

Q.2 Construct turing machine for checking even palindrome string over $\Sigma = \{0, 1\}$.

⇒ Soln :-

• Transition diagram:



- Transition table:

	a	b	Δ
q_0	$\{q_1, \Delta, R\}$	$\{q_4, \Delta, R\}$	$\{q_7, \Delta, R\}$
q_1	$\{q_1, a, R\}$	$\{q_1, b, R\}$	$\{q_2, \Delta, L\}$
q_2	$\{q_3, \Delta, L\}$		
q_3	$\{q_3, a, L\}$	$\{q_3, b, L\}$	$\{q_0, \Delta, R\}$
q_4	$\{q_4, a, R\}$	$\{q_4, b, R\}$	$\{q_4, \Delta, L\}$
q_5		$\{q_6, \Delta, L\}$	
q_6	$\{q_6, a, L\}$	$\{q_6, b, L\}$	$\{q_0, \Delta, R\}$
q_7			

- Simulation :

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

$= (\{q_0, q_1, q_2, q_3, q_4, q_5, q_6, q_7\}, \{a, b\}, \{a, b\}, \delta, q_0, \Delta, \{q_7\})$.

abbaΔ $\vdash$ (q_0) abba Δ

$\vdash$ $\Delta\ (q_1)$ bba Δ

$\vdash$ Δ b (q_1) ba Δ

$\vdash$ Δ bb (q_1) a Δ

$\vdash$ Δ bba (q_2) Δ

$\vdash$ Δ bb (q_2) a Δ

$\vdash$ Δ b (q_3) b $\Delta\Delta$

$\vdash$ $\Delta\ (q_3)$ bb $\Delta\Delta$

$\vdash$ $\Delta\ (q_3)\ \Delta$ bb $\Delta\Delta$

$\vdash$ $\Delta\ (q_0)$ bb $\Delta\Delta$

$\vdash$ $\Delta\Delta\ (q_4)$ b $\Delta\Delta$

$\vdash$ $\Delta\Delta$ b (q_4) $\Delta\Delta$

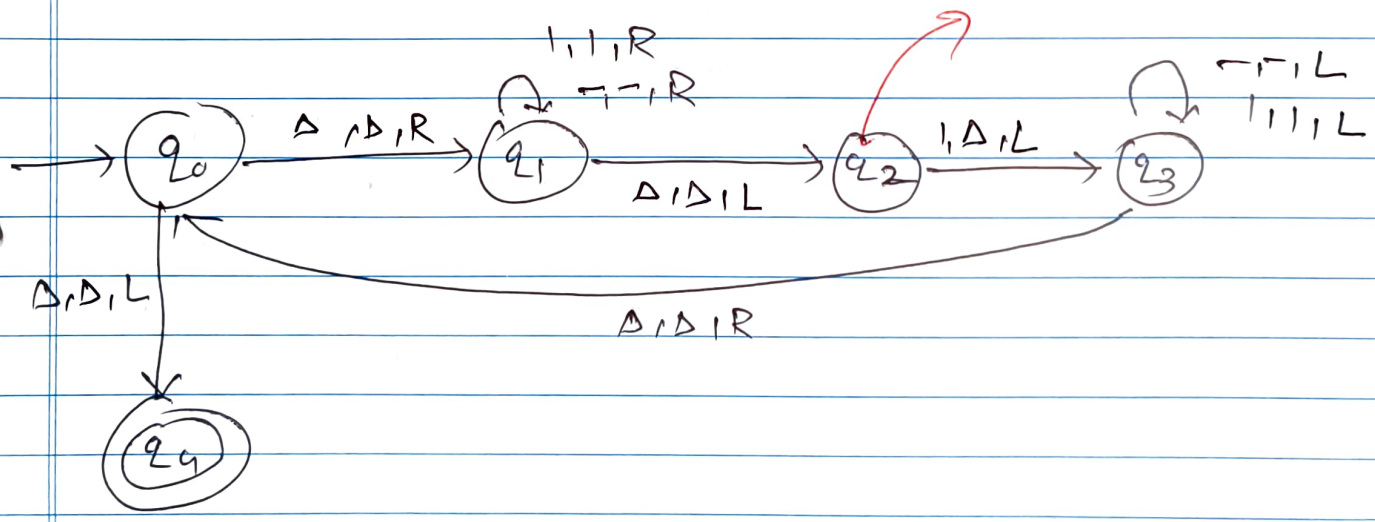
$\vdash \Delta\Delta(q_5)b\Delta\Delta$
$\vdash \Delta(q_6)\Delta b\Delta\Delta$
$\vdash \Delta\Delta(q_0)b\Delta\Delta$
$\vdash \Delta\Delta(q_0)\Delta\Delta\Delta$
$\vdash \Delta\Delta(q_7)\Delta\Delta\Delta$

$\therefore$ I/P string is accepted.

Q.3 Design TM to substract two unary numbers assume $m > n$

$\Rightarrow$ Sol^n:-

- Transition diagram :



- Transition table:

	1	-	Δ
q_0	$\{q_1, \Delta, R\}$		$\{q_4, \Delta, R\}$
q_1	$\{q_1, 1, R\}$	$\{q_1, -, R\}$	$\{q_2, \Delta, L\}$
q_2	$\{q_3, \Delta, L\}$		
q_3	$\{q_3, 1, L\}$	$\{q_3, -, L\}$	
q_4			

- Simulation:

$(q_0)111-11\Delta$

$\vdash (q_0)111-11\Delta$
$\vdash \Delta(q_1)11-11\Delta$
$\vdash \Delta 1(q_1)1-11\Delta$
$\vdash \Delta 11(q_1)-11\Delta$
$\vdash \Delta 11-1(q_1)1\Delta$
$\vdash \Delta 11-11(q_1)\Delta$
$\vdash \Delta 11-1(q_2)1\Delta$
$\vdash \Delta 11-(q_2)\Delta\Delta$
$\vdash \Delta 11(q_2)-1\Delta\Delta$
$\vdash \Delta 1(q_2)1-1\Delta\Delta$
$\vdash \Delta(q_2)11-1\Delta\Delta$
$\vdash (q_2)\Delta 11-1\Delta\Delta$
$\vdash \Delta(q_0)11-1\Delta\Delta$
$\vdash \Delta\Delta(q_1)1-1\Delta\Delta$
$\vdash \Delta\Delta 1(q_1)-1\Delta\Delta$
$\vdash \Delta\Delta 1-(q_1)1\Delta\Delta$
$\vdash \Delta\Delta 1-(q_2)1\Delta\Delta$
$\vdash \Delta\Delta 1-(q_1)\Delta\Delta\Delta$

$\vdash \Delta\Delta \vdash (q_2)\Delta\Delta$.

∴ TM can be defined as –

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

$M = (\{q_0, q_1, q_2, q_3, q_4\}, \{1, -\}, \delta, \{1, -\}, q_0, \Delta, \{q_4\})$.

Q.4 Define turing machine and explain different variants of turing machine.

⇒

- Turing machine is an abstract mathematical model of computation that was introduced by mathematical and compute scientist Alan Turing in 1930's.
- It can solve any mathematical problem.
- The prime components of turing machine are :

1) TAPE : An inficiently any tape divided into cells and holds a symbol from finite alphabet, including Δ symbol.

2) READ/WRITE head : A head that can read the symbol at its current position on tape and write a new symbol.

- Types of turing machine:

1) Standard Turing Machine

⇒ This is the original and most basic form of turing machine. It can read, write, and erase symbols on the tape, and its rules are defined by a transition function that maps the current state and the symbol under the head to a new state, new symbol to write and a direction in which to move the head.

2) Nondeterministic Turing Machine (NTM)

⇒ Unlike a standard TM, an NTM can be in multiple states at once and explore various computational paths simultaneously.

3) Universal Turing Machine (UTM)

⇒ A UTM is a turing machine capable of simulating any other turing machine.

- It has a special program on its tape that encodes the description of the machine it is simulating.
- A UTM can execute the steps of the simulated machine, effectively making it a universal computer.