SET- A

1)

a) ii (Recursively Enumerable)

b) iv (Infinite tape)

c) $L = \{$ unary addition $\}$

d) Transition rules

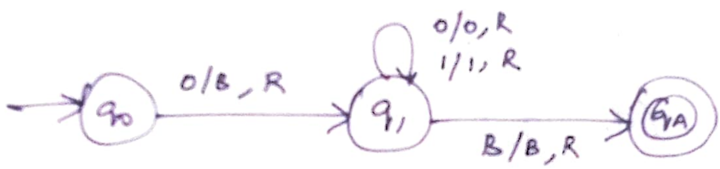
1) $\delta(q_0, 0) = (q_1, B, R)$

2) $\delta(q_1, 0) = (q_1, 0, R)$

3) $\delta(q_1, 1) = (q_1, 0, R)$

4) $\delta(q_1, B) = (q_A, B, R)$

e)



	0	1	B
$\rightarrow q_0$	(q_1, B, R)	-	-
q_1	$(q_1, 0, R)$	$(q_1, 0, R)$	(q_A, B, R)
$* q_A$	-	-	-

f) Computing device

g) $w = 000001000$

$q_0 000001000B \vdash Bq_1 00001000B \vdash B0q_1 0001000B$

$\vdash B00q_1 001000B \vdash B000q_1 01000B \vdash B0000q_1 1000B$

$\vdash B00000q_1 000B \vdash B000000q_1 00B \vdash B0000000q_1 0B$

$\vdash B00000000q_1 B \vdash B00000000Bq_A B.$

$\therefore$ TM halts and output is computed.

Set A:

2) a) iv (Recursive)

b) iv) (L is recursive)

c)

Lets assume red as a

yellow as b

$L = \{a^n b^n \mid n \geq 1\}$.

) Transition rules

1) $\delta(q_0, a) = (q_1, x, R)$

2) $\delta(q_1, a) = (q_1, a, R)$

3) $\delta(q_1, b) = (q_2, Y, L)$

4) $\delta(q_2, a) = (q_2, a, L)$

5) $\delta(q_2, X) = (q_0, x, R)$

6) $\delta(q_1, Y) = (q_1, Y, R)$

7) $\delta(q_2, Y) = (q_2, Y, L)$

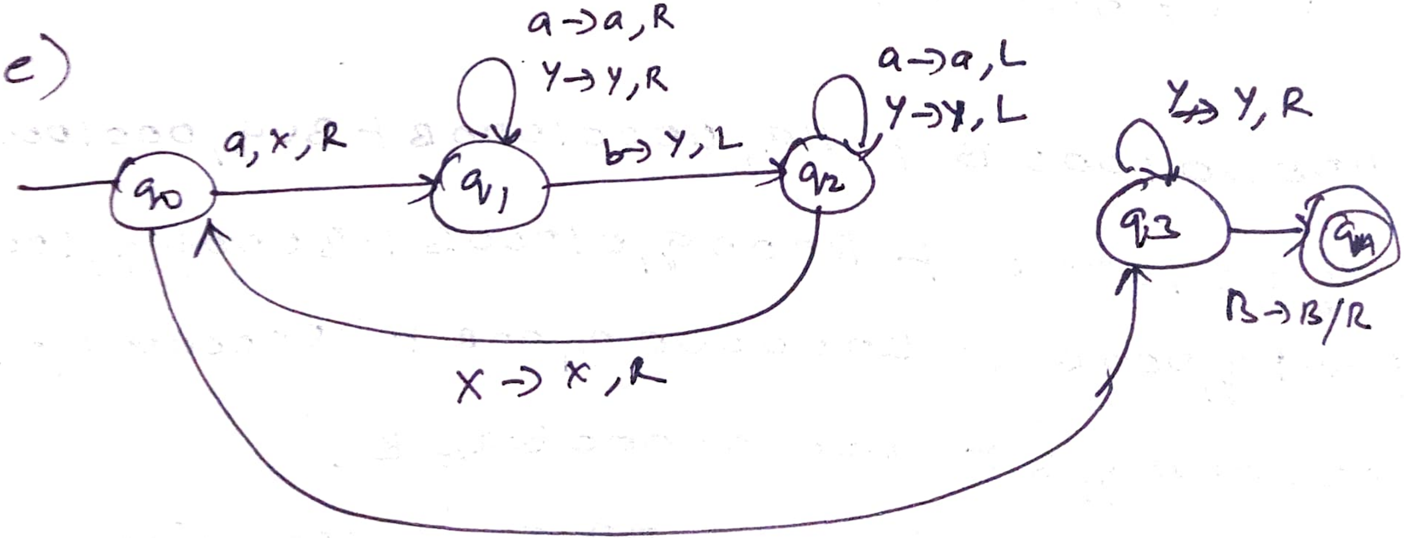
8) $\delta(q_0, Y) = (q_3, Y, R)$

9) $\delta(q_3, Y) = (q_3, Y, R)$

10) $\delta(q_3, B) = (q_4, B, R)$

d) transition diagram & table

e)



yellow as b

$L = \{a^n b^n \mid n \geq 1\}$.

d) transition diagram & table

e) encode the message.

Lets assume

q_0 - 0	a - 0	L - 0
q_1 - 00	b - 00	R - 00
q_2 - 000	X - 000	
q_3 - 0000	Y - 0000	
q_A - 00000		

For each transition encode ~~the~~ and the coded M/

0101001000100110010100101001 1

00100100010000101 1 0001010001010

Similarly encode all transitions.

f)

List A	List B
RYY	YYYR
YYR	YRYR
RR	RRY
YY	YRY

... have solution because all the ...

yellow as b

$L = \{a^n b^n \mid n \geq 1\}$.

d) transition diagram & table

e) encode the message.

Lets assume

q_0 - 0   a - 0   L - 0

q_1 - 00   b - 00   R - 00

q_2 - 000   X - 000

q_3 - 0000   Y - 0000

q_A - 00000

For each transition encode: and the coded m

0101001000100 11 00101001010011

0010010001000010 11 000101000101O

Similarly encode all transitions.

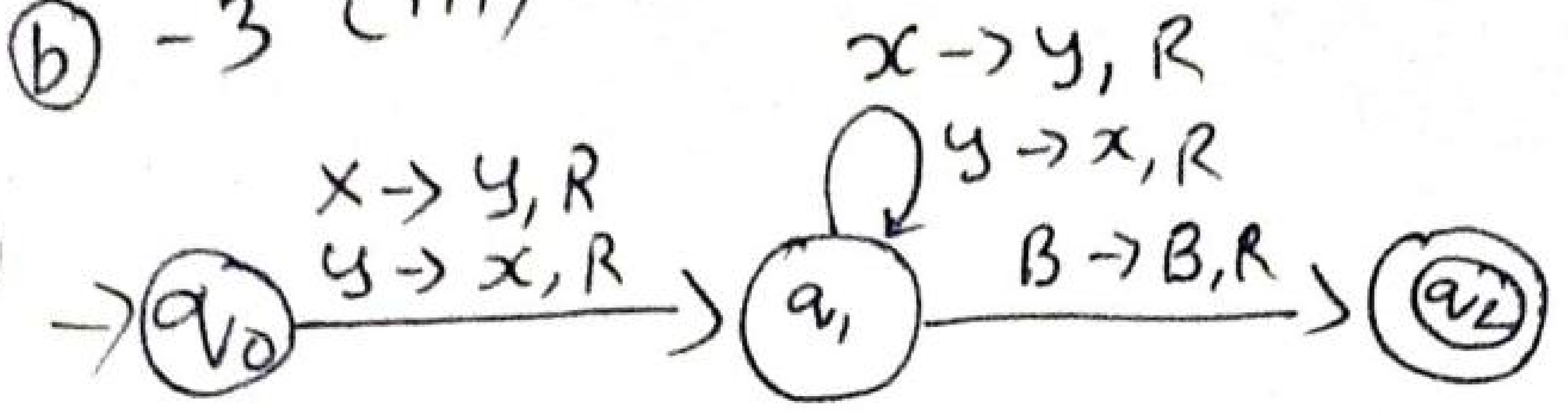
f)

List A	list B
RYY	YYYR
YYR	YRYR
RR	RRY
YY	YRY

Doesnt have solution. because all the perm combination doesnt give solution.

③ ⓐ - 3 (iii)

ⓑ - 3 (iii)

ⓒ 

ⓓ $\delta(q_0, x) = (q_1, y, R)$

$\delta(q_0, y) = (q_1, x, R)$

$\delta(q_1, x) = (q_1, y, R)$

$\delta(q_1, y) = (q_1, x, R)$

$\delta(q_1, B) = (q_2, B, R)$

step 1 = $\boxed{\dfrac{\#}{\# q_0 w \#}}$

step 2 : Right moves

$\boxed{\dfrac{q_0 x}{y q_1}}$ $\boxed{\dfrac{q_0 y}{x q_1}}$ $\boxed{\dfrac{q_1 x}{y q_1}}$ $\boxed{\dfrac{q_1 y}{x q_1}}$

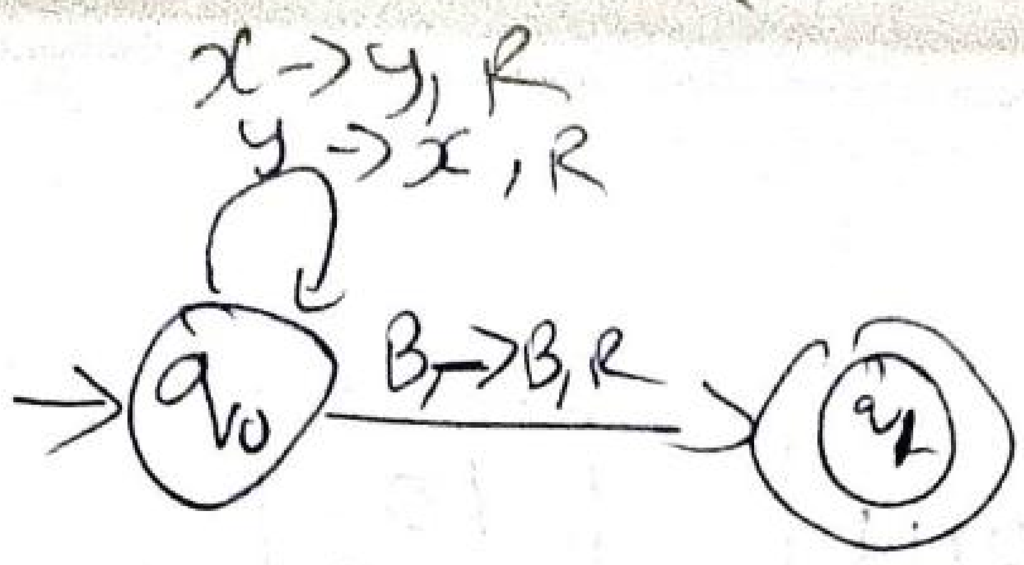
③ $\boxed{\dfrac{x}{x}}$ $\boxed{\dfrac{y}{y}}$ $\boxed{\dfrac{B}{B}}$

④ $\boxed{\dfrac{x q_2}{q_2}}$ $\boxed{\dfrac{q_2 x}{q_2}}$ $\boxed{\dfrac{y q_2}{q_2}}$ $\boxed{\dfrac{q_2 y}{q_2}}$

⑤ $\boxed{\dfrac{\#}{\#}}$ $\boxed{\dfrac{\#}{B \#}}$ ⑥ $\boxed{\dfrac{q_2 \# \#}{\#}}$

(or)

(d)



$\delta(q_0, x) = (q_0, y, R)$

$\delta(q_0, y) = (q_0, x, R)$

$\delta(q_0, B) = (q_1, B, R)$

step1 : $\dfrac{\#}{\# q_0 w \#}$

step2 : $\boxed{\dfrac{q_0 x}{y\, q_0}}$ $\boxed{\dfrac{q_0 y}{x\, q_0}}$

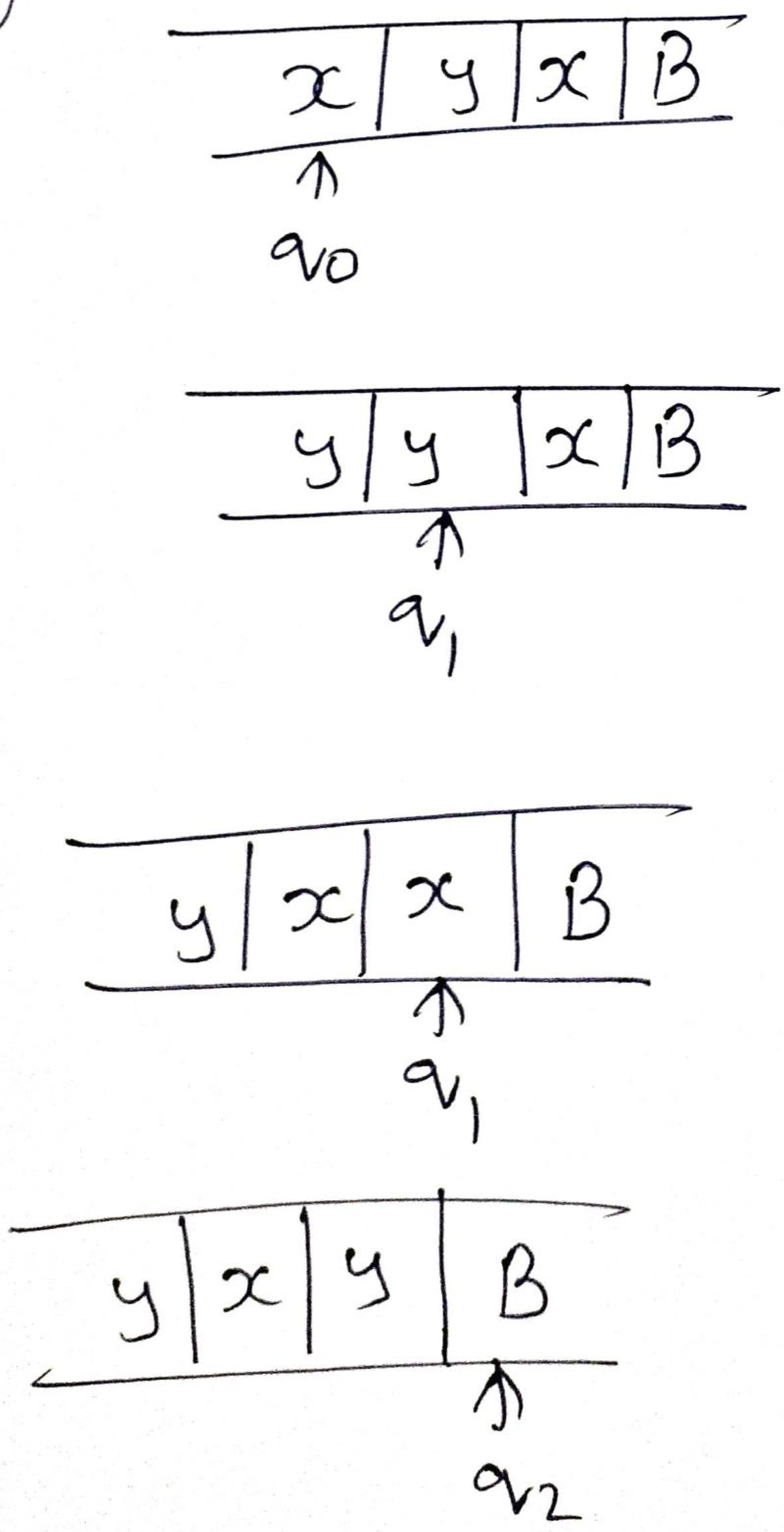
(3) $\boxed{\dfrac{x}{x}}$ $\boxed{\dfrac{y}{y}}$ $\boxed{\dfrac{B}{B}}$

(4) $\boxed{\dfrac{x\, q_1}{q_1}}$ $\boxed{\dfrac{q_1 x}{q_1}}$ $\boxed{\dfrac{y\, q_1}{q_1}}$ $\boxed{\dfrac{q_1 y}{q_1}}$

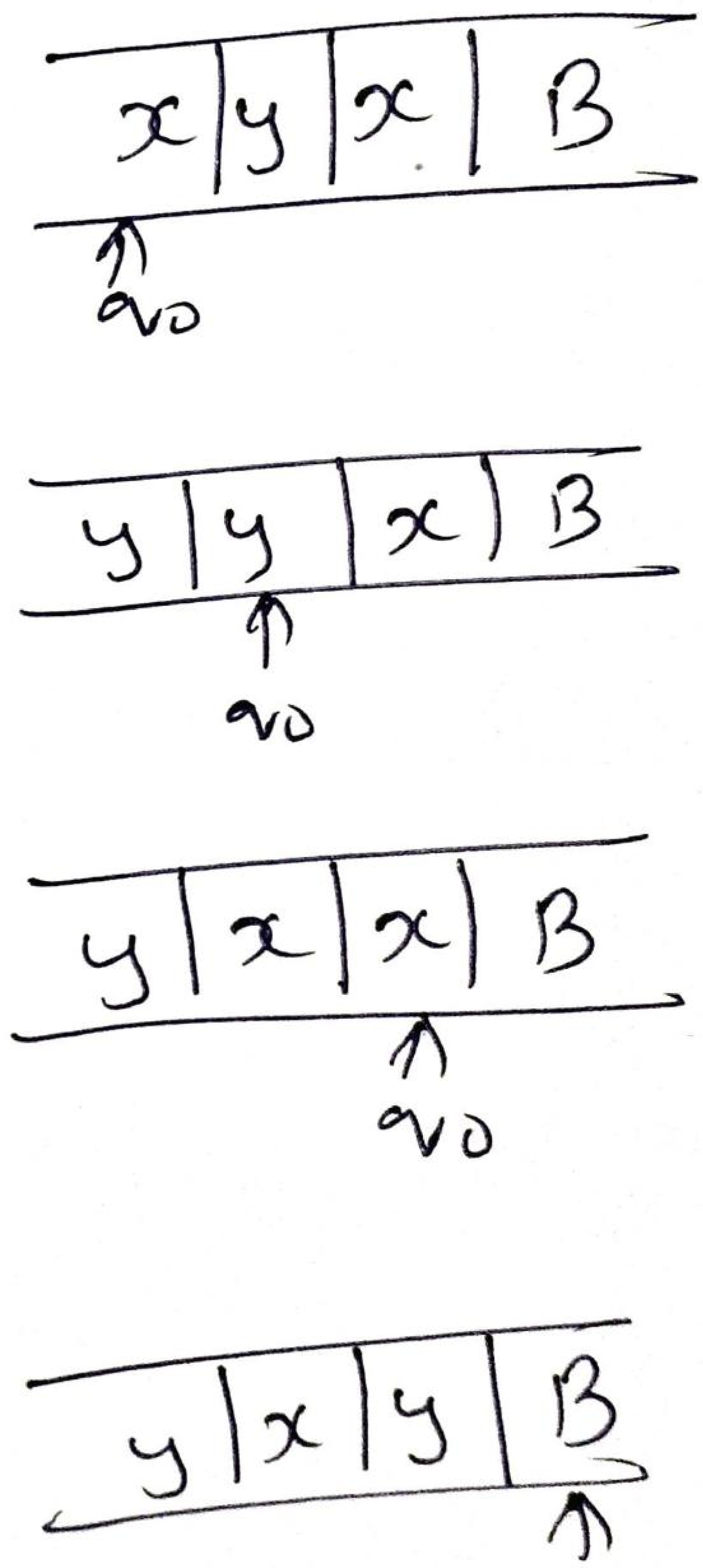
(5) $\boxed{\dfrac{\#}{\#}}$ $\boxed{\dfrac{\#}{B\#}}$

(6) $\boxed{\dfrac{q_1 \#\#}{\#}}$

(e)



(or)



(8) $w = xyx$

$\frac{\#}{\# q_0 w \#}$ $\boxed{\frac{\#}{\# q_0 xyx \#}}$

$\frac{\#}{\# q_0 \cancel{x}\cancel{y}\cancel{x}\cancel{\#}}$ $\boxed{\frac{q_0 x}{y q_1}}$ $\boxed{\frac{y}{y}}$ $\boxed{\frac{x}{x}}$ $\boxed{\frac{\#}{\#}}$ $\boxed{\frac{\#}{\# q_0 x}}$ $\boxed{\frac{\#}{\#}}$

$\boxed{\frac{q_0 x}{y q_1}}$ . . . . It loops

Set - B

1) a) iv) recursive

b) i) TM that accepts L

c) $a^{2n} b^n$ (2)

X X X X Y Y

| a | a | a | a | b | b | B | B |

(8)

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

$\delta(q_1, a) = (q_2, X, R)$

$\delta(q_2, a) = (q_2, \cancel{X}, R)$

$\delta(q_2, b) = (q_3, Y, L)$

$\delta(q_3, a) = (q_3, a, L)$

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

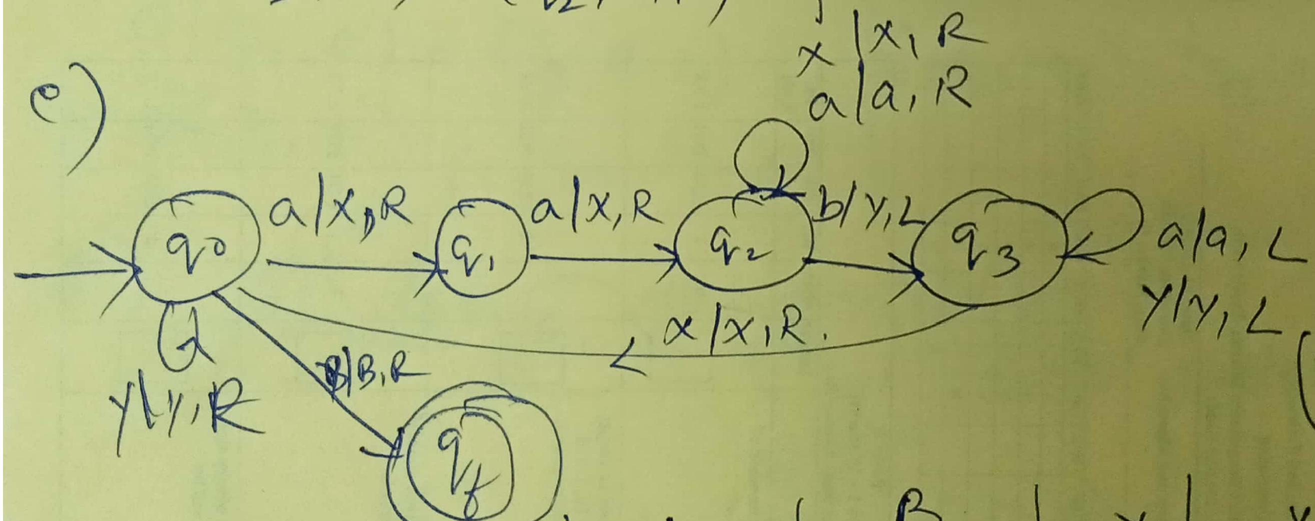
$\delta(q_3, Y) = (q_3, Y, L)$

$\delta(q_3, X) = (q_0, X, R)$

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

$\delta(q_0, B) = (q_f, B, R)$

e)



(2½)

	a	b	B	Y	X
q_0	(q_1, X, R)		(q_f, B, R)	(q_0, Y, R)	
q_1	q_2, X, R				
q_2	q_2, X, R	(q_3, Y, L)		(q_2, X, R)	
q_3	(q_3, a, L)			(q_3, Y, L)	~~q_3~~ (q_0, X, R)
q_f	–	–	–	–	–

(2½)

1) Yes CFG. use pumping lema (4) ②

g) $n=3$

$w = aa\cancel{abb}abbb$ (4)

2) a) ii) long

b) ii)

c) $f(x) = a-4$

~~w=aaaa~~ encode ~~4~~ .

(7)

1) $\delta(q_0, 0) = (q_0, 0, R)$

$\delta(q_0, B) = (q_1, B, L)$

$\delta(q_1, 0) = (q_2, B, L)$

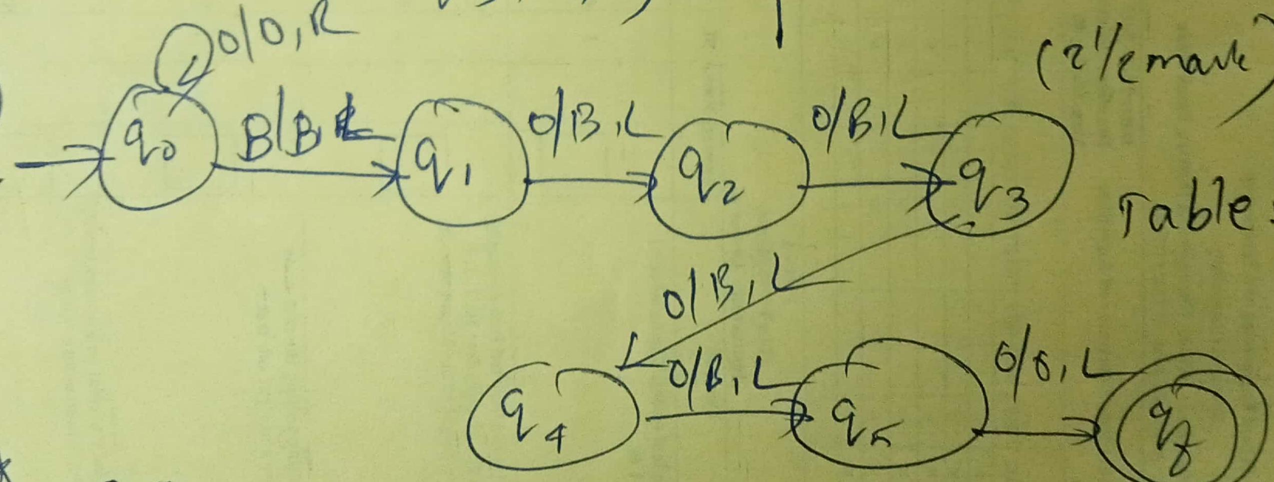
$\delta(q_2, 0) = (q_3, B, L)$

$\delta(q_3, 0) = (q_4, B, L)$

$\delta(q_4, 0) = (q_5, B, L)$

$\delta(q_5, 0) = (q_f, 0, L)$

d)



(2½ mark)

Table: 2½ ma

~~e)~~ ~~(5)~~

~~e) (7)~~ ~~encode~~ .

$\cancel{g_0}$

e) $w = 0000000BB.$ ③

$\cancel{q_0000}$

f) Let $q_0 = 0$, $q_1 = 00$, $q_2 = 000$, $q_4 = 0000$, $q_5 = 00000$

$q_f = 000000$, 0 as 0000000 R as 000000000

1 as 00000000

$(q_0, 0) = (q_0, 0, R)$

01001010100000001000000000

like wise code for all rules.

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3) a) ii)

(4)

b) ~~S22~~ iv)

c) $\frac{10111}{10} = \frac{1111}{111} = \frac{11}{111} = \frac{1}{1111} = \frac{10}{10}$

$\frac{10}{0}$ 10: $\frac{1}{111} =$

2, 1, 1, 1, 3 (8)

d) ~~undec~~.
e) ~~yes~~.
f) ~~No~~.

d) (6)

	A	B
0	~~x0~~ x1x	x1x1x1
1	1x	x1x1x1
2	1x0x1x1x1x	x1x0
3	1x0x	x0
4	$	x$

e) yes. ~~can~~ generate the sequence (5)

f) ~~yes~~. MPCP is undecidable — (1)

Justification — (3)

a) Turing Machine (TM) tape head can move in left, right, up or down direction in
   i. Multi-tape TM
   ii. Multi-head TM
   iii. Multi-track TM
   iv. Multi-dimensional TM

b) A: The Machine Halts when there is no possible transition to follow
   B: The TM final state has an outgoing transition
   Which of the following is true ?
   i. A and B are true
   ii. A and B are false
   iii. A is true and B is false
   iv. A is false and B is true

c) Generate the accepting language L for the given scenario. Jay vists a store to buy some gallon of milk and bread. First she buys milk followed by bread, which is twice the quantity of milk. Design a TM for the generated language

d) Draw a transition diagram and Transition table of the constructed TM

e) Is it a Computing device or an acceptor. Justify the answer

Simulate a TM for MilkMilkBreadBreadBread

Set C

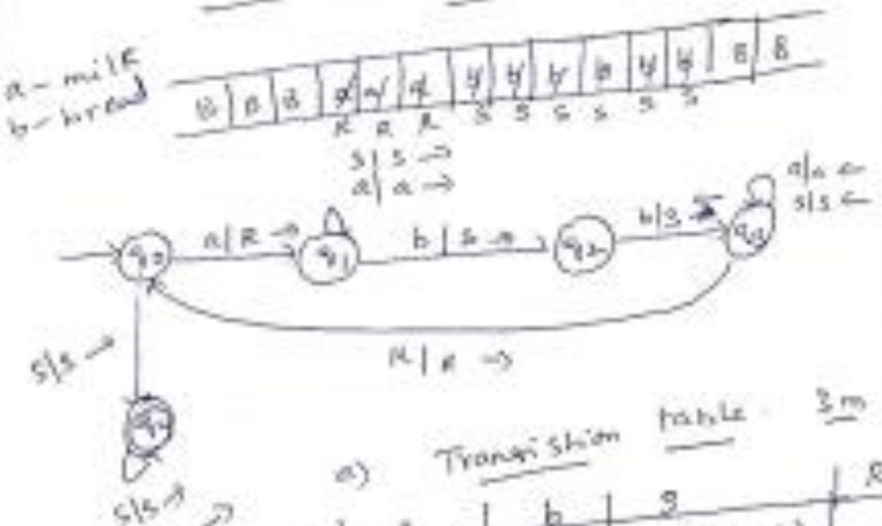
Q1.

1 a) iv – multi dimensional TM – 1 mark

b) iii – A is true and B is false – 1 mark

c) $L = \{ a^n b^{2n} \mid n \geq 1 \}$ – 3 m

d) Transition diagram – 5m



e) Transition table 3 m

	a	b	S	R	B
q_0	(q_1, R, R)	—	(q_4, S, R)		—
q_1	(q_1, a, R)	(q_2, S, R)	(q_1, S, R)		—
q_2	—	(q_3, S, L)	—		—
q_3	(q_3, a, L)		(q_3, S, L)	(q_0, R, R)	
q_4			(q_4, S, R)		(q_4, B, R)

— 3 marks

(c) The machine accepts all the language even though they are recursively enumerable. Recursive means repeating the same set of rules for any no. of times and enumerable means a set of elements.

3. milk milk bread bread bread — 9m.

(q_0, milk milk bread bread bread) ⊢

(~~milk~~ R q_0 milk ~~milk~~ bread bred bread) ⊢

(R milk q_1 ~~milk~~ bread bread bred) ⊢

(R milk 5 q_2 bread bread) ⊢ 9 marks

(R milk 5 q_3 5 bread) ⊢

(R milk q_3 5 5 bread) ⊢

(R q_0 milk 55 bread) ⊢

(R R q_1 55 bread) ⊢

(R R 5 q_1 5 bread) ⊢

(R R 5 5 q_1 bread) ⊢

(R R 5 5 5 q_2) ⊢

q_2 is not final state

Hence the given string not accepted

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An UPI based online payment application wishes to attract new customers. In this perspective, it has decided to give a reward of Rs 5 for every transaction made to the sender as well as the receiver of the amount.

a) The Turing machines are brain child of __________

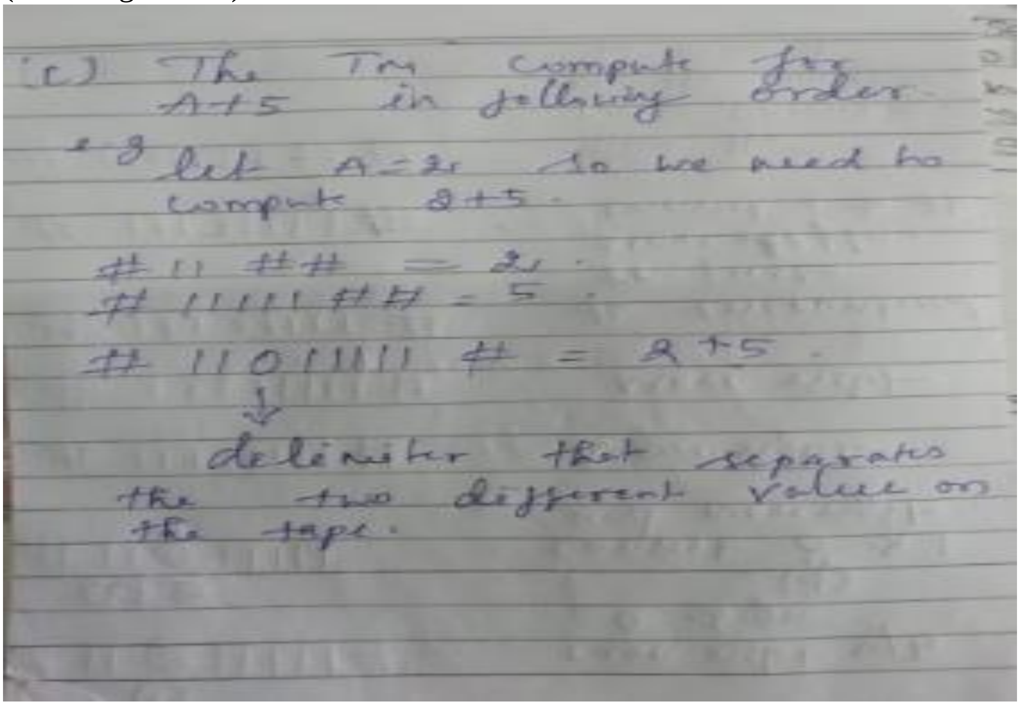
  i) **Programming languages**

  ii) Microprocessors

iii) Stored program concept
iv) Microcontrollers

b) If MPCP can be solved then PCP can also be solved. Which property illustrates this?
i) Computational complexity
ii) **Decidability**
iii) Reducibility
iv) Computability

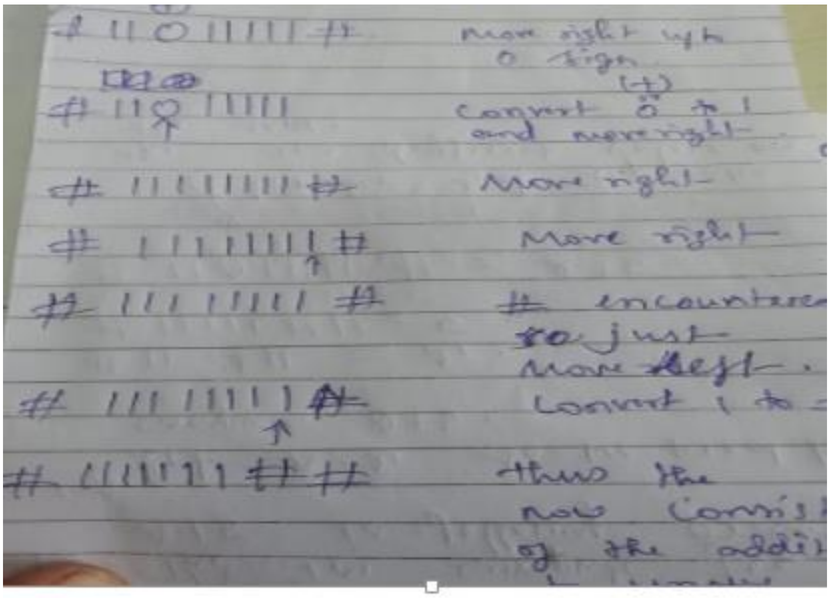
c) Construct a TM transition rules that calculates the total amount of the receiver (including reward).


(c) The TM compute for A+5 in following order

e.g let A = 2 so we need to compute 2+5.

11 ## = 2.
11111 ## = 5.
11 0 11111 # = 2+5.

delimiter that separates the two different value on the tape.


11 0 11111 # — Move right upto 0 sign (+)

11 0 11111 — Convert 0 to 1 and move right

11111111 # — Move right

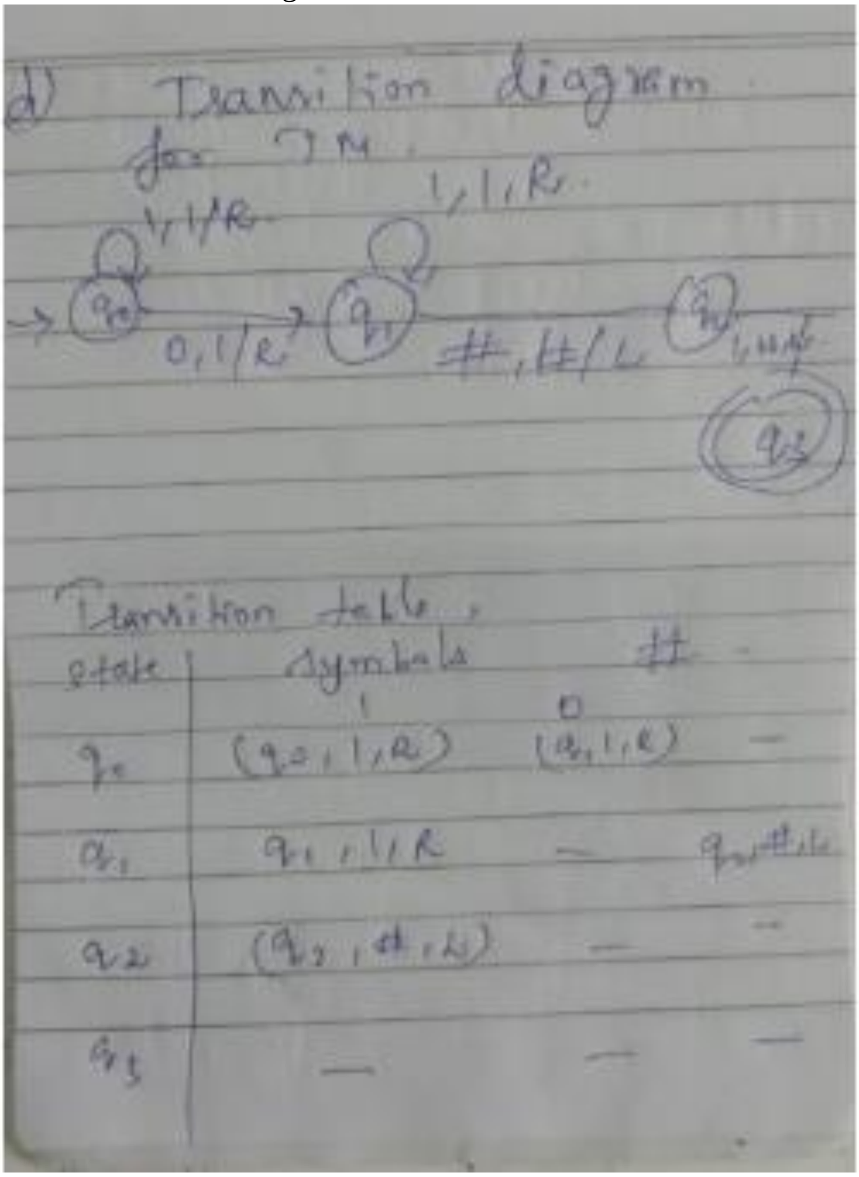
11111111 # — Move right

11111111 # — # encountered so just move left.

111 11111 # — Convert 1 to

11111111 ## # — thus the now consis of the addi

d) Draw the transition diagram and table for the same



Transition table.

state	symbols 1	0	#
q_0	(q_0, 1, R)	(q_1, 1, R)	—
q_1	q_1, 1, R	—	q_2, #, L
q_2	(q_2, #, L)	—	—
q_3	—	—	—

e) Compute the total amount at the receiver if the actual transaction is Rs 6. Illustrate it using instantaneous description

e) Given A = 6 & we have to compute 6 + 5

consider the input tape

1	1	1	1	1	1	0	1	1	1	1	1	#	#	#

q_0

The instantaneous description will be —

$q_0\ 111111011111\# \vdash 1q_0\ 11111011111\#$
$\vdash 11q_0\ 1111011111\# \vdash 111q_0\ 111011111\#$
$\vdash 1111q_0\ 11011111\# \vdash 11111q_0\ 1011111\#$
$\vdash 111111q_1\ 111111\# \vdash 1111111\ q_1\ 11111\#$
$\vdash 11111111q_1\ 1111\# \vdash 111111111q_1\ 111\#$
$\vdash 1111111111\ q_1\ 11\# \vdash 11111111111\ q_1 1\#$
$\vdash 111111111111\ q_1\# \vdash 111111111111\ q_f\#\#$

Hence, the result is 11.

f) Binary encoding of TM —

T- tuple representation of TM with ... on the top :

Encode the constructed TM in binary language and then decode them. (6 marks)

$\{(q_0', q_1'', q_2''', q_f''''), (0', 1''), (0', 1'', \#'''),$

$(\delta(q_0', 1'') \rightarrow (q_0', 1'', R'')), \delta(q_0', b) \rightarrow (q_1'', 1'', R''),$

$\delta(q_1'', 1'') \rightarrow (q_2'', 1'', R''), \delta(q_1'', \#''') \rightarrow (q_2''', \#''', L'),$

$\delta(q_2''', 1'') \rightarrow (q_f'''', \#''', L')), q_0', \#''',$

$q_f''''\}$ [Decoded form of TM]

The binary encoded form is

$M = \{ \underbrace{1011011101111}_{Q} 00 \underbrace{1011}_{\Sigma} 00 \underbrace{1011011}_{\Gamma}$

$00 \underbrace{10110101011011}_{\delta_1} 0 \underbrace{1010110110110}_{\delta_2} 0$

$\underbrace{11011011011011}_{\delta_3} 0 \underbrace{1101110111101110}_{\delta_4}$

$\underbrace{0111011011110111 01}_{\delta_5} 00 \underbrace{1}_{q_0} 00 \underbrace{111}_{\#} 00$

$\underbrace{1111}_{q_f} \}$

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Every year a common festival is celebrated between two villages A and B. On an account of this, a local sport is organized by the villagers. The selection of players in this year happens according to the given table (Here 0 indicates women and 1 indicates men). The positioning of the players is made in such a way that at any particular position, if village A places a set of players from set i, then village B should also place the set of players from set I only. This pattern will repeat for other sets also.

i	A	B
1	11	10110
2	111	000
3	001	0101
4	010	0

a) Consider the statements:
 S1: All recursively enumerable languages are countable.
 S2:Set of all non-regular languages over the alphabet {a,b,c} is recursively enumerable.
 i) **Both are true**
 ii) Only S1 is true
 iii) Only S2 is true
 iv) Both are false

b) A NP complete problem is the conjunction of__________
 i) NP hard and NP
 ii) NP and P
 iii) NP hard and P
 iv) NP hard alone

c) An audience claims that there are atleast two ways in which the men and women of villages A and B can be placed after fulfilling the condition of the game. Is this true? If yes, give the sequence.

d) Assuming the above given table is a MPCP problem, convert it into PCP.

e) Construct a TM, for another game in which if village A places men then village B should place woman and vice versa. Design a TM to help village B in doing so.

Find the arrangement of village B if the village A places players in the following order: "men, women, women, men".

Set – D

1) a) iii)

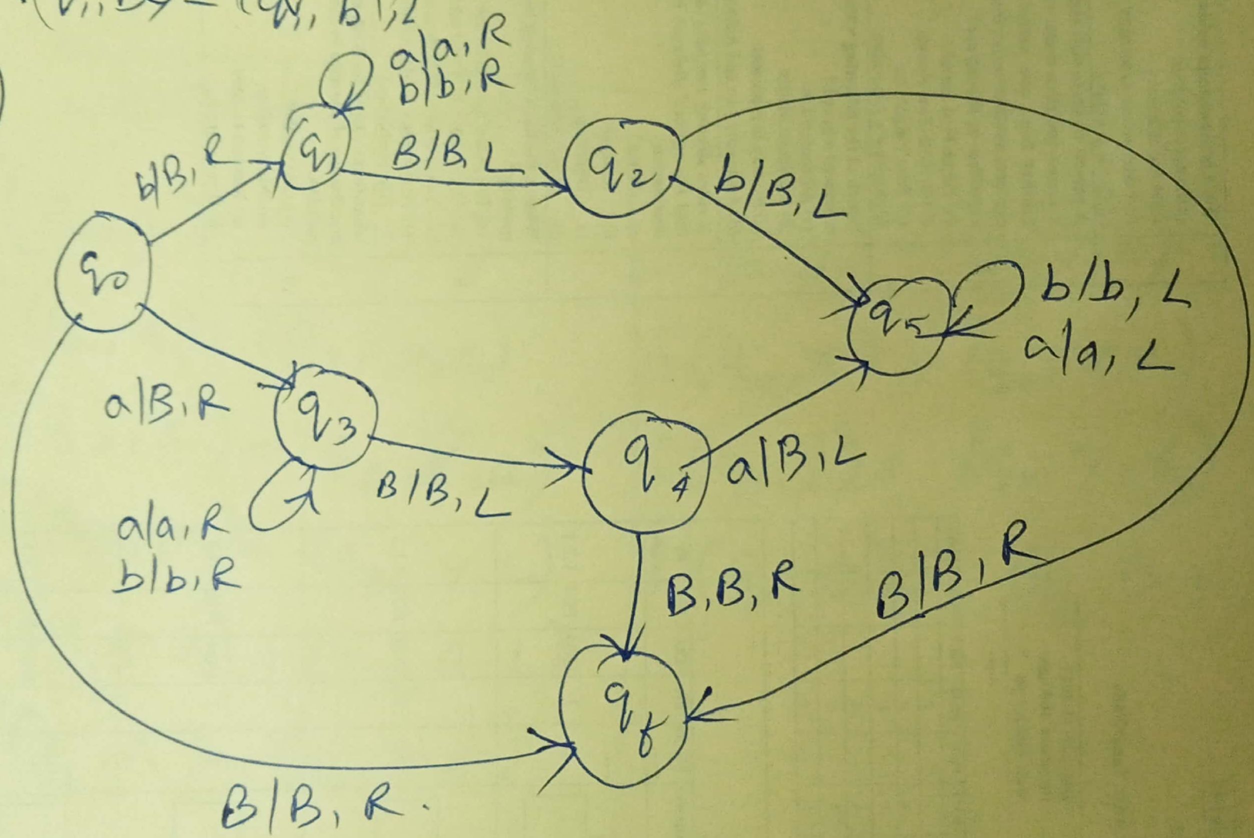
b) ii)

c) ~~$\delta(q_0, a) = (q_1, x, R)$~~

~~$\delta(q_1, a) = (q_1, a, R)$~~

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

d)



e, d) Give rules & table for above diagram

c) $L = \{ww^R \mid w \in \{a, b\}\}$

f) Acceptor – 1 mks

Justification – 1 mks.

g) $w = aaa$ accepted. ②

Give the instantaneous description.

2) a) c)

b) d)

c) $L = \{a^{2n} b^n \mid n \geq 1\}$ (10)

| a | a | a | a | b | b | B | B. |

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

$\delta(q_1, a) = (q_2, X, R)$

$\delta(q_2, a) = (q_2, a, R)$

$\delta(q_2, b) = (q_3, Y, L)$

$\delta(q_3, a) = (q_3, a, L)$

$\delta(q_3, X) = (q_2, X, R)$

$\delta(q_3, Y) = (q_3, Y, L)$

$\delta(q_3, X) = (q_0, X, R)$

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

$\delta(q_0, B) = (q_f, B, R)$

d) draw dia (4 mks)

Table (3)

e) Encode. (6 mks)

Make assumptions like.

$q_0 = 0$, $a = 00$, $q_1 = 000$, $X = 0000$, $R = 00000$

rule ① 0100100010000100000 11 . . . . . .

3) a) iv)

b) iv)

c) (5)

$\delta(q_0, 1) = (q_0, 1, R)$

$\delta(q_0, 0) = (q_0, 0, R)$

$\delta(q_0, B) = (q_f, k, R)$

d) Draw table (2 mks)

Draw dia (2 mks)

e) a = 1011B

after instantaneous description

a = 1011k

f)

	list X	Y
~~Group I For each x in ... add~~		

3) f)

	X	Y
Basic string	#	# q_0 1011 #
Group I	0	0
	1	1
	#	#
Group II		
~~For each~~		
$(q_0, 1) = (q_0, 1, R)$	$q_0 1$	$1 q_0$
$(q_0, 0) = (q_0, 0, R)$	$q_0 0$	$0 q_0$
$\delta(q_0, B) = (q_f, k, R)$	$q_0 \#$	$k q_f \#$
Group III		
	$0 q_f 0$	$\# q_f$
	$1 q_f 1$	q_f
	$1 q_f 0$	q_f
	$0 q_f 1$	q_f
	$0 q_f$	q_f
	$1 q_f$	q_f
	$q_f 0$	q_f
	$q_f 1$	q_f
Group IV	$q_f \# \#$	#