Math 322

Turing Machines

states

q

r/w head

| # | | # | S_1 | S_2 | $\cdots$ | S_n | # | # |

blank   input string
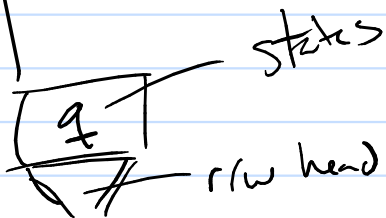
actual of T is based on input - output function δ

(input pair) $\xrightarrow{\delta}$ (output triple)

(ar) as digraph

$(i)(o,m)$

q_i $\longrightarrow$ q_j

input pair   output triple
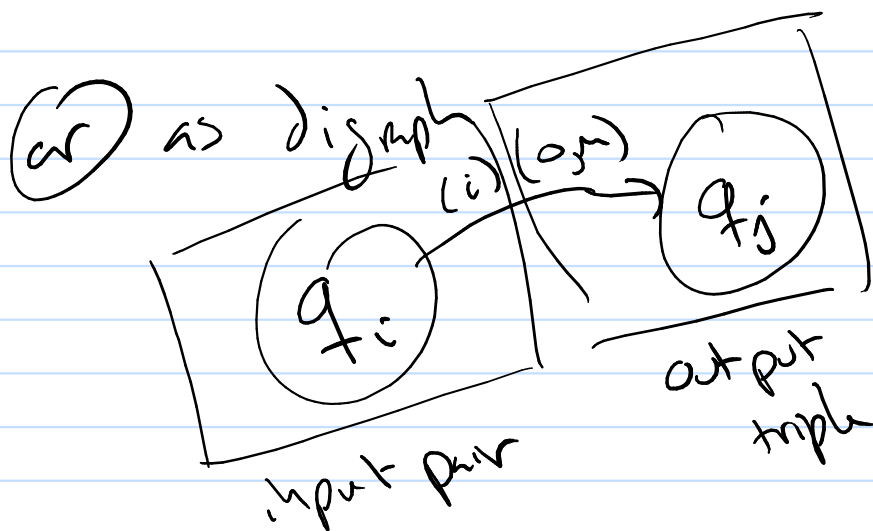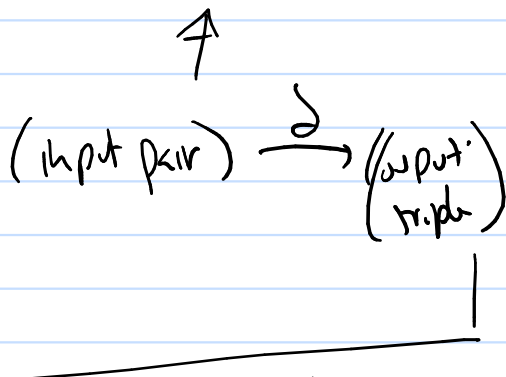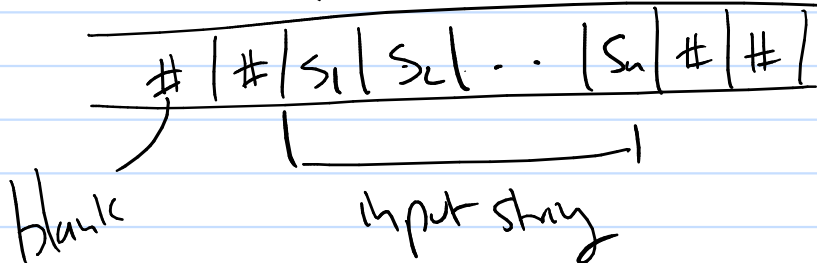
or as a 5-tuple

(input pair, output triple)

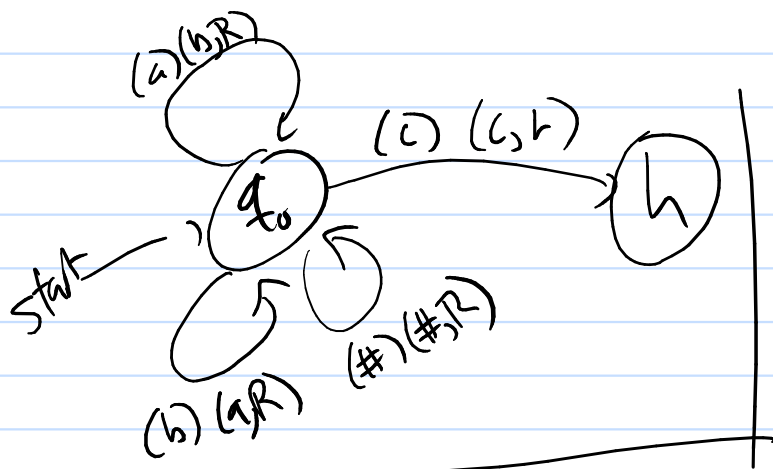**Note**   Make a turing machine --

① find the 5-tuples

② states = knowledge for the task
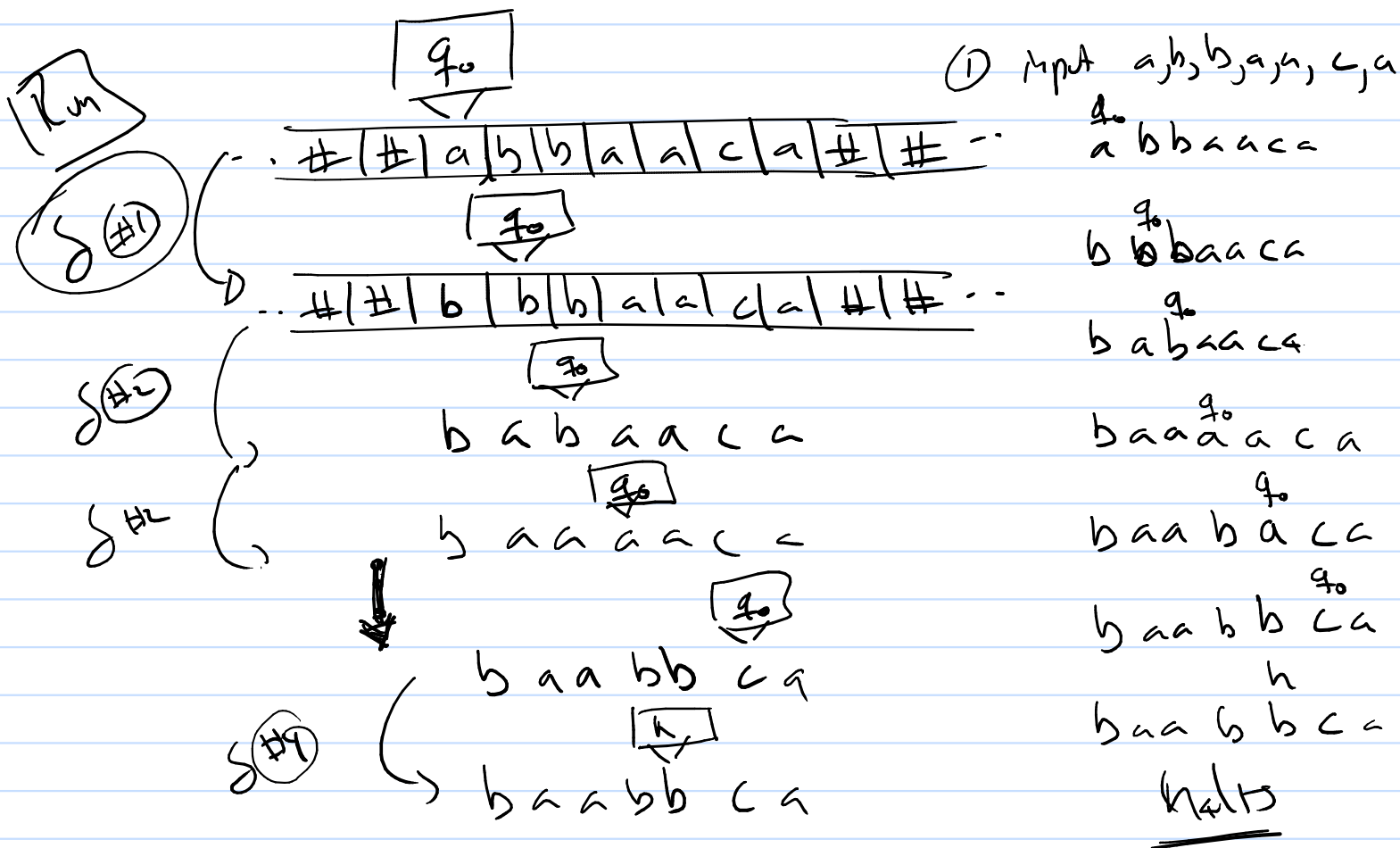
    input / output = doing the task upon input

$$\delta$$

① $(q_0, a) \rightarrow (b, R, q_0)$

② $(q_0, b) \rightarrow (a, R, q_0)$

③ $(q_0, \#) \rightarrow (\#, R, q_0)$

④ $(q_0, c) \rightarrow (c, L, h)$

5 tuples:

(q_0, a, b, R, q_0) (q_0, c, c, L, h)

(q_0, b, a, R, q_0)

$(q_0, \#, \#, R, q_0)$

$$\Lambda = \{ \#, a, b, c \} \qquad S = \{ q_0, h \}$$

Run

δ ①

···	#	#	a	b	b	a	a	c	a	#	#	···

q_0

···	#	#	b	b	b	a	a	c	a	#	#	···

q_0

δ ②

b a b a a c a

q_0

δ #2

b a a a a c a

q_0

b a a b b c a

δ #4

b a a b b c a

h

① mph a,b, b,a,..., c,a

q_0
a b b a a c a

q_0
b b b a a c a

q_0
b a b a a c a

q_0
b a a a a c a

q_0
b a a b a c a

q_0
b a a b b c a

h
b a a b b c a

halts

Make turing Machines?

(ex) unary numbers

$0 = 1$
$1 = 11$
$2 = 111$
$3 = 1111$
$4 = 11111$
$\vdots$

$2 + 2 = 4$

$\underbrace{1,1,1}_{2},\underbrace{+},\underbrace{1,1,+}_{2}$

} run T

$1,1,1,1,1$

$0 + 5 = \boxed{5}$

$1 \circledast 1 1 1 1 1 \boxed{++}$
} 1

$1 1 1 1 1 1$

$0 + 0 = 0$

$1, \circledast, +$
} 1

1

$q_0 =$ not seen $+$
$q_1 =$ saw $+$, made it 1
$q_c =$ saw the (1)
$q_b =$ blank an 1 from end
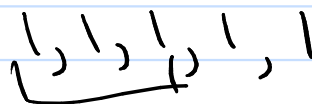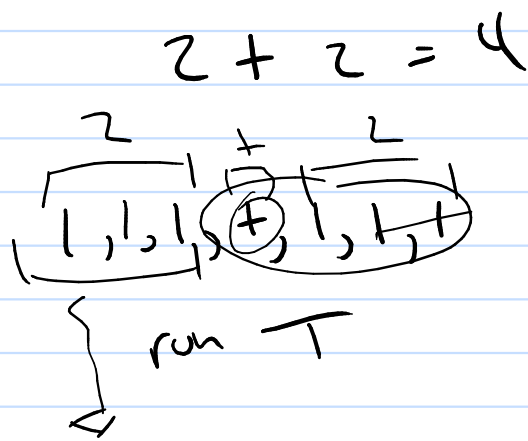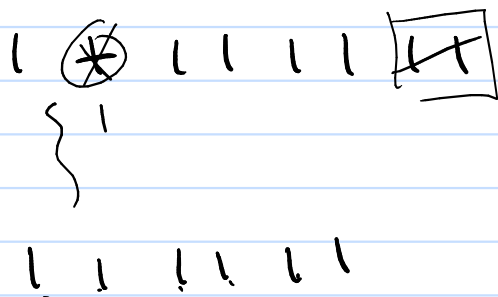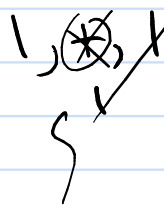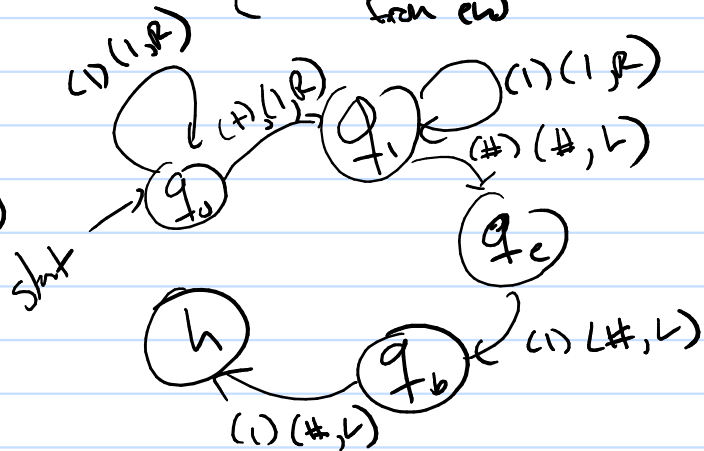
$(q_0, 1) \xrightarrow{\delta} (1, R, q_0)$

$(q_0, +) \rightarrow (1, R, q_1)$

$(q_1, 1) \rightarrow (1, R, q_1)$

$(q_1, \#) \rightarrow (\#, L, q_c)$

$(q_c, 1) \rightarrow (\#, L, q_b)$

$(q_b, 1) \rightarrow (\#, L, h)$

Q how many Turing Machines exist for $|\Lambda| = n$

and $|S| = M$?

T is a <u>set</u> of 5-tuples

$$(S_{tate}, input) \rightarrow (output, \overset{L}{\underset{R}{r}}, S_{tate})$$

all T's are some subset of all 5-tuples

So $|T| = 2^{|all\ tuples|} = 2^{M \wedge \wedge 2M}$

$= 2^{2n^2 m^2} = 4^{n^2 m^2}$

ex only have $\#, 1$ $\quad |\Lambda| = 2$

only have q_0, h $\quad |S| = 2$

$|T| = 4^{44} = 2^{2 \cdot 4 \cdot 4} = 2^{32}$

Exam 12 probs @ 10pts

3.2 Regular Expressions $\boxed{2\ probs}$

① given an expression $(ex\ \underline{a^* | b a b^*})$

↳ a) describe its strings

b) give examples of a string from it.

② description $\rightarrow$ give the expression

$(0|1)^* 010$

$0(0|1)^* 1$

| 4.1 / 4.5 / 4.6 | Grammars | (lectures) | 2 probs |

① given production → name the grammar

ⓔⓧ $S \to \varepsilon$, $S \to aA$, $A \to Db$, $A \to a$
        type $0, 1, 2$ or 3 not 3   1
        context free

② given productions , give the language
                              all strings produced by
                              productions

ⓞⓡ

Ask if a given string is in the language.

(lecture)   State machines with output   (2 prbs)

① Identify Machine

② Run a machine on specific input
   → give output.

| 3.4 / 3.5 | FSA   (3 probs)

① $L(DFA)$ ③ given NFA
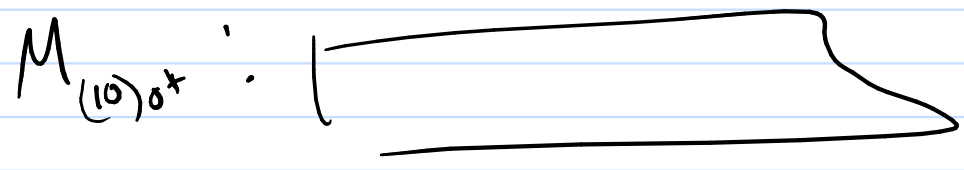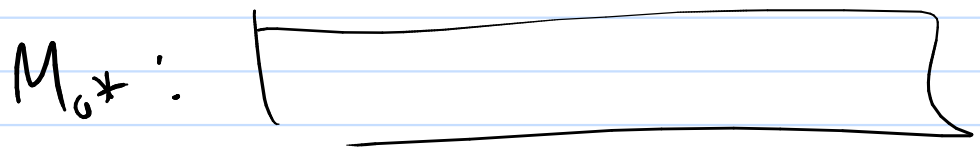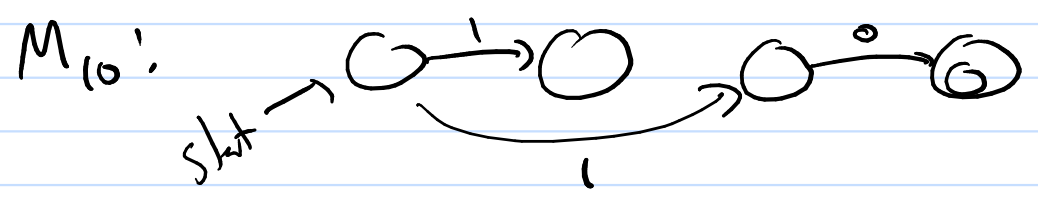② $L(NFA)$ you find DFA

3.6 Regular Expression and FSA   1 prob

(1) given regular expression

→ Make FSA for it using
the tech. of textbook/lecture.
(induction making of Machines)

ex $(10)0^*$

M_1: M_0:

M_{10}:
   start

M_{0^*}:

$M_{(10)0^*}$:

___

5.1 Turing Machines   (2 probs)

(1) run a given T   explain states

(2) make a T

   (1) slmy modification

   (2) unary number, take modulus