

HW3

1  
a) The language of all binary strings that contain at least two 1's.

b) The set of all strings that contain 'eg' or 'ge' as a substring over the language (c, e, g)

2.

a) begins with a 1 and ends with a 0

Hence,  $1(0+1)^*1$

b) doesn't contain substring 110

$0^*(10^+)^*1^*$

c) contains even number of 0s or two 1's

$1^*(01^*01^*)^* + 0^*10^*10^*$

d) all strings except the empty string

$= (0+1)^+$

3

a) LHS:  $(\epsilon \cup X)^* Y$   
 $= \{ \epsilon, X, XX, XXX, \dots \}$

Produces any no. of  $X$  or  $\epsilon$

Do  $(\epsilon \cup X)^* = X^*$

$(\epsilon \cup X)^* Y = X^* Y = \text{RHS}$

Hence this is true

b) False

$(X \cup Y)^*$  produces string containing  $X$  and  $Y$  or  $\epsilon$

lets say  $(X \cup Y)^*$  produces  $XXX \in (X \cup Y)^* Y^*$

and  $(X^* X)^*$  produces a string containing  $X$  and  $X$  and ends in  $Y$  or  $\epsilon$ .

$YXX \notin (X^* X)^*$

False. as RHS is not the same as LHS.



c)  $Y(XYUX)^* = (YXUX)^*X$

$Y \in Y(XYUX)^*$  as it is produced first.

$X \notin (YXUX)^*X$  since a single  $Y$  cannot be produced.

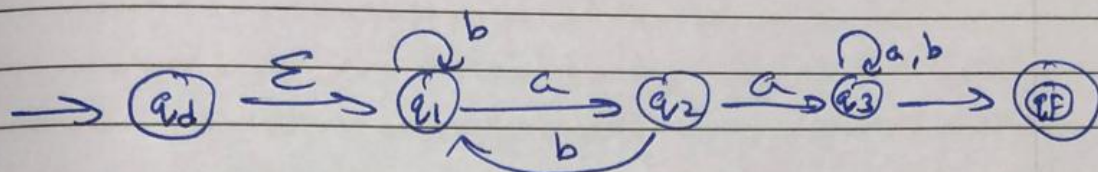
False





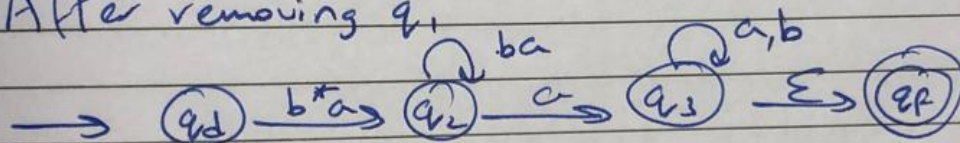
5. 1. We add a new start state  $q_d$  with a  $\epsilon$  to the old state

2. We add a new final state  $q_f$  with a  $\epsilon$  from the old state

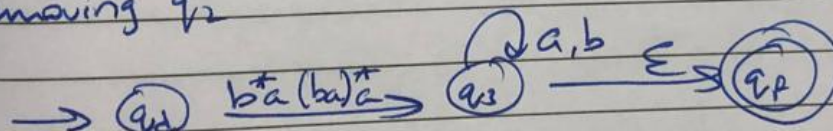


3. Remove steps and do the transition

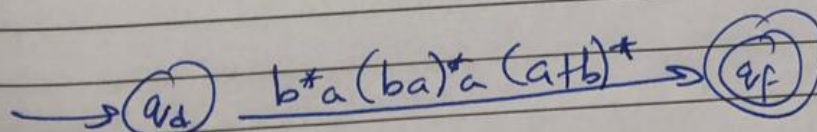
After removing  $q_1$



Removing  $q_2$



Removing  $q_3$



6. We can say that JH-Lisp is a regular language, as it represents finite sets, which in turn represents a ~~finite language~~ regular language.

Although, we can say that it being regular depends on the expression, in general, JH-Lisp's properties are represented as a regular language. When we see an example:

$$L = \{ a^x + b^x \mid n \leq 1^{20} \}, \text{ this}$$

is regular as it is upper bounded and is a finite language, thus making it regular.

However if we take  $L = \{ x^p \mid p \text{ is prime} \}$ ,

this is not regular so there is no pattern that can be repeated, hence its regularity depends on the expression.