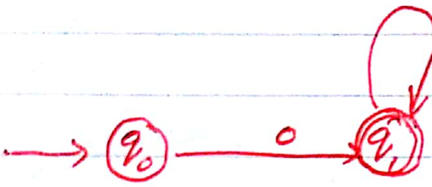
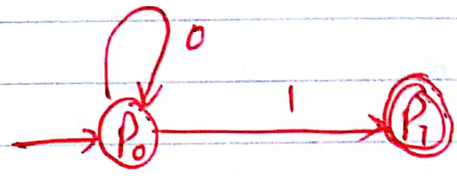
Non Deterministic Finite Automata with Λ Transitions



(a)

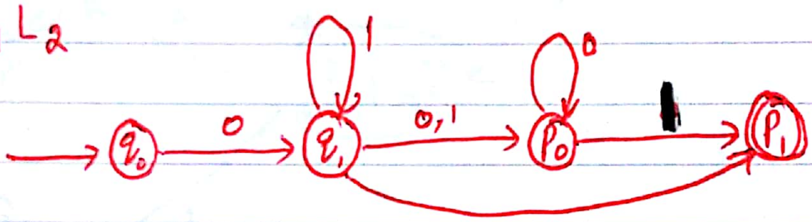
L_1 = An NFA accepting $\{0\}\{1\}^*$



(b)

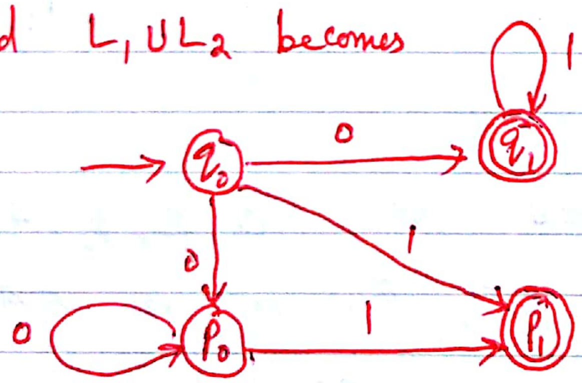
L_2 = An NFA accepting $\{0\}^*\{1\}$

Then $L_1 L_2$



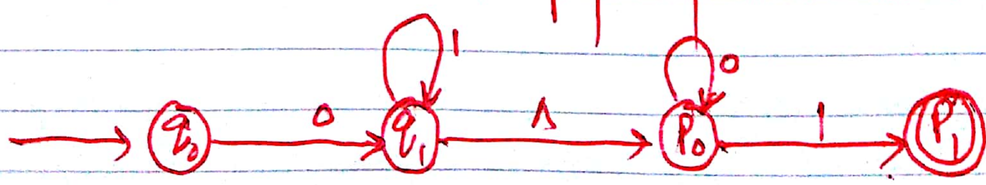
An NFA accepting $\{0\}\{1\}^*\{0\}^*\{1\}$

and $L_1 \cup L_2$ becomes



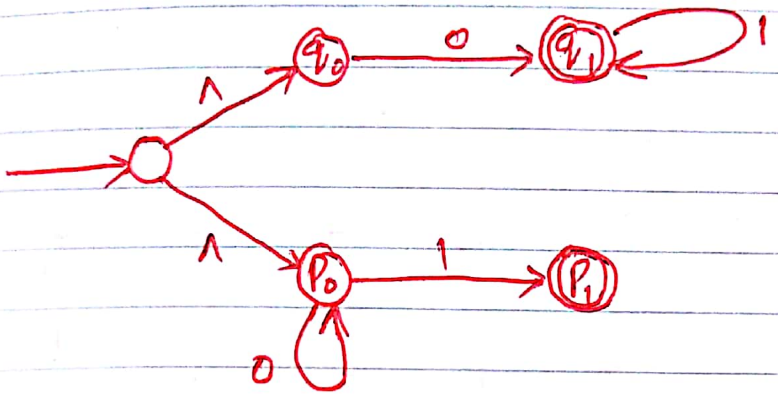
An NFA accepting $\{0\}\{1\}^* \cup \{0\}^*\{1\}$

we Can solve it simply by Λ Transitions



NFA-Λ accepting 01^*0^*1

and



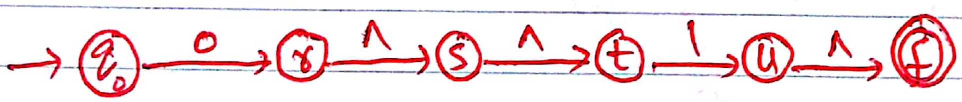
NFA-Λ accepting $01^* \cup 0^*1$

<u>Definition</u>

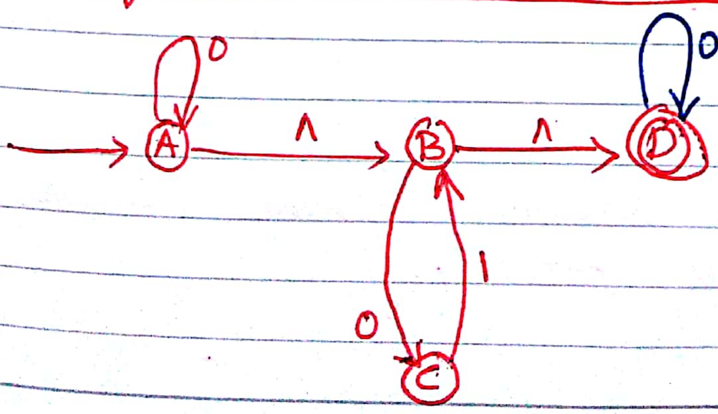
A NFA with Λ transition (NFA-Λ) is 5 tuple $(Q, \Sigma, q_0, A, \delta)$ where Q and Σ are finite sets $q_0 \in Q$, $A \subseteq Q$ and

$$\delta : Q \times (\Sigma \cup \{\Lambda\}) \rightarrow 2^Q$$

<u>Example</u> for string '01'



<u>Converting an NFA-Λ to an NFA</u>



(a)

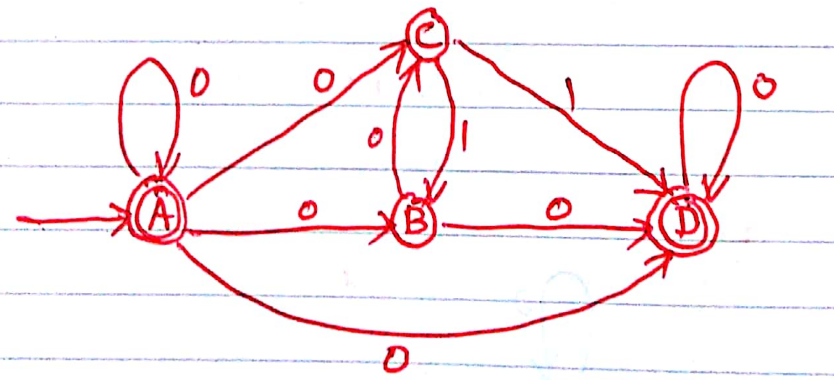
q	$\delta(q,\Lambda)$	$\delta(q,0)$	$\delta(q,1)$
A	B	A	ϕ
B	D	C	ϕ
C	ϕ	ϕ	B
D	ϕ	D	ϕ

q	$\delta^*(q,0)$	$\delta^*(q,1)$
A	A, B, C, D	ϕ
B	C, D	ϕ
C	ϕ	B, D
D	D	ϕ

15 MONDAY ٢٨ ربيع الاول

16 TUESDAY ٢٩ ربيع الاول

Now NFA becomes

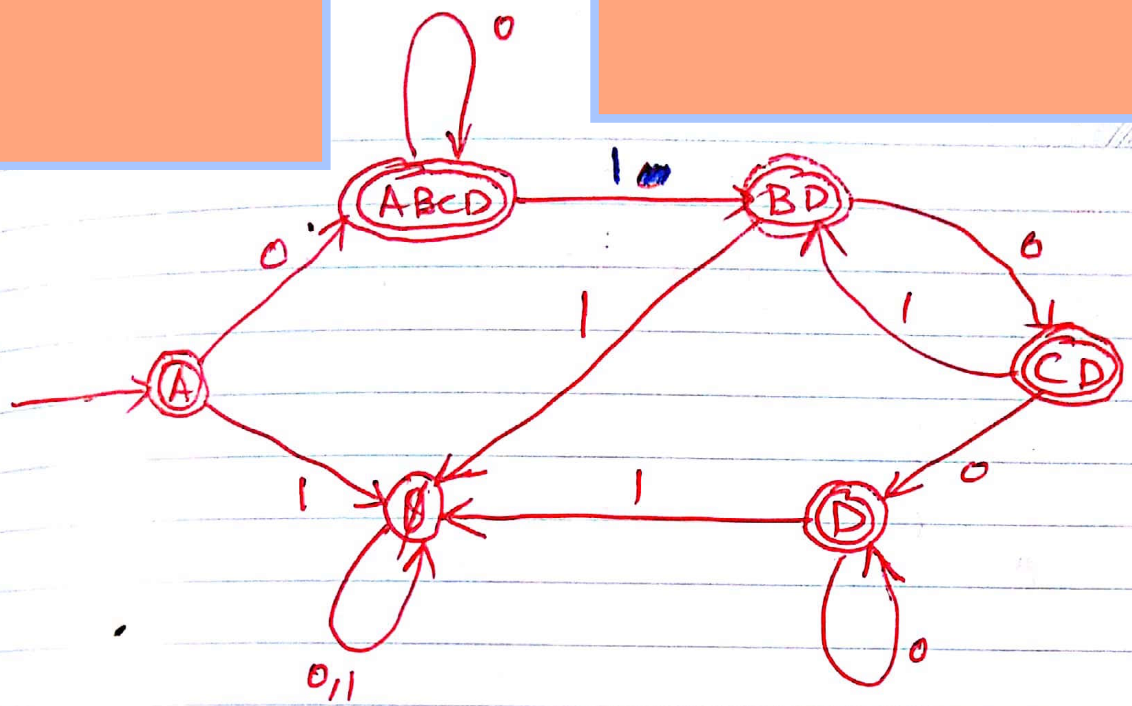


'A' becomes the final state, since Λ is minimum string in Language

Now FA from previous procedure becomes as given in the next Page.

[redacted]

[redacted]



Definition (Λ - closure of a Set of states)

Let $M = \{Q, \Sigma, q_0, A, \delta\}$ be an NFA-Λ and let S be any subset of Q. The Λ-closure of S is the set $\Lambda(S)$ defined as follows.

1. Every element of S is an element of $\Lambda(S)$
2. for any $q \in \Lambda(S)$, every element $\delta(q, \Lambda)$ is in $\Lambda(S)$.
3. No other elements of Q are in $\Lambda(S)$.

Example

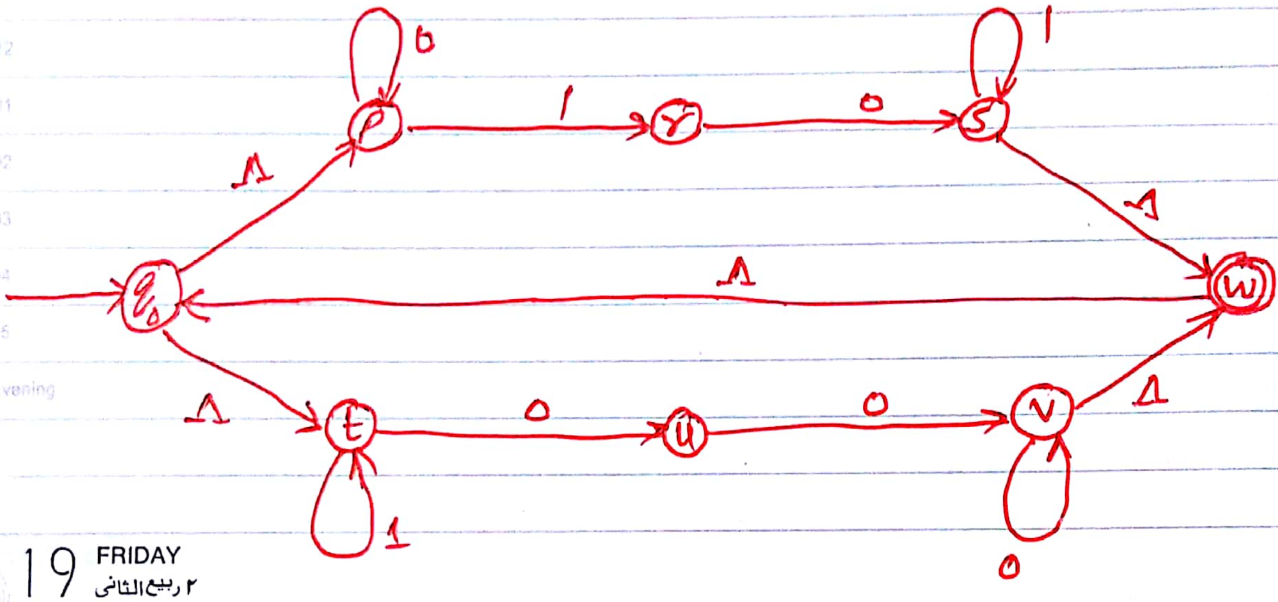
$$\delta^*(q_0, \Lambda) = \Lambda(\{q_0\}) = \{q_0, p, t\}$$

$$\delta^*(q_0, 0) = \Lambda\Big(\bigcup_{p \in \delta^*(q, \Lambda)} \delta(p, 0) \Big)$$

here, q is q-zero

$$= \Lambda\left(\delta(q_0,0) \cup \delta(p,0) \cup \delta(t,0)\right)$$

$$= \Lambda\left(\emptyset \cup \{p\} \cup \{u\}\right) = \Lambda(\{p,u\}) = \{p,u\}$$



19 FRIDAY ٢ ربيع الثاني

20 SATURDAY ٣ ربيع الثاني 21 SUNDAY ٤ ربيع الثاني

$$\delta^*(q_0,01) = \Lambda\left(\bigcup_{p\in\delta^*(q_0,0)} \delta(p,1)\right)$$

$$= \Lambda\left(\delta(p,1) \cup \delta(u,1)\right) = \Lambda(\{r\}) = \{r\}$$

$$\delta^*(q_0,010) = \Lambda\left(\bigcup_{p\in\delta^*(q_0,01)} \delta(p,0)\right)$$

$$= \Lambda\left(\delta(r,0)\right) = \Lambda(\{s\}) = \{s, w, q_0, p, t\}$$

KLEEN'S Theorem

(i)- Every reguler language has an FA
(ii)- Every ~~language~~ FA has some language which is regular.

Regular languages are closed under Union, Concatenation and Kleen*

1. $\{L_1, FA_1\}$ and $\{L_2, FA_2\}$ $\Rightarrow$ $\{L_3, FA_3\}$

   such that $L_3 = L_1 \cup L_2$

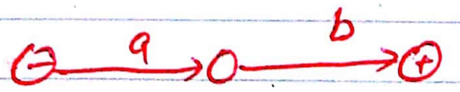
   and $L_3 =$ [redacted] or $L_1 L_2$

2. $\{L_1, FA_1\} \Rightarrow \{L_3, FA_3\}$

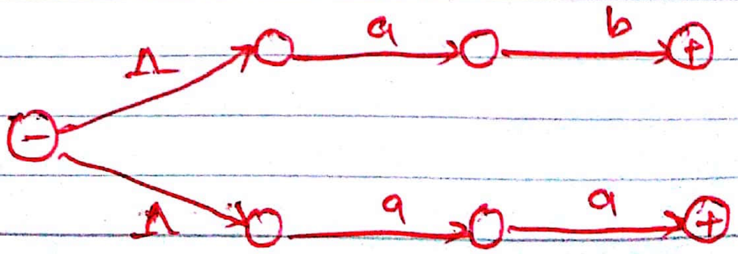
   where $L_3 = L_1^*$

Example

① $FA_1 \cup FA_2 = FA_3$

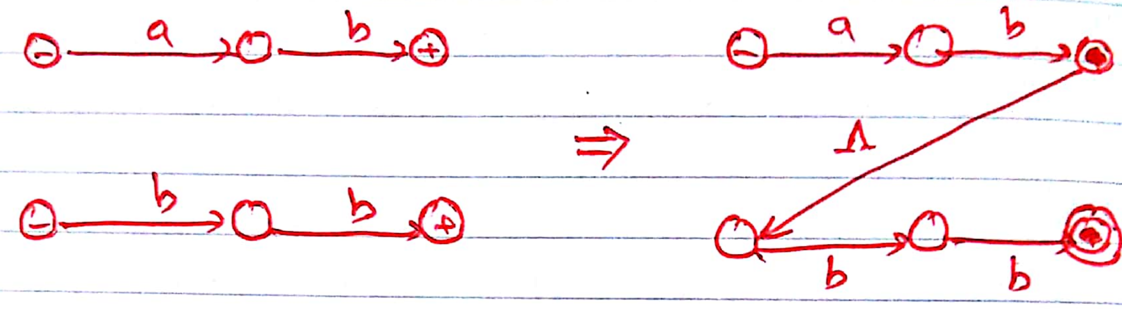
FA_1  $\{ab\}$

FA_2  $\{aa\}$

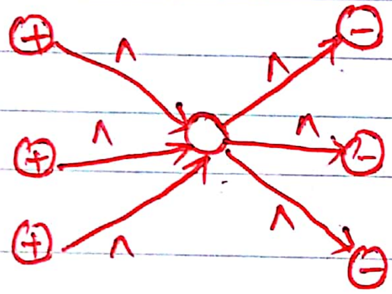


by adding another initial state with Λ transitions

② $FA_1 FA_2 = FA_3$



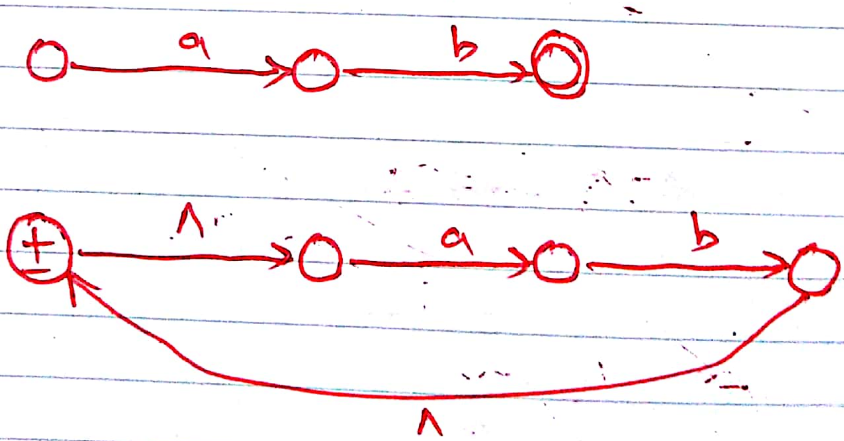
FA_1 FA_2



24 WEDNESDAY
٧ ربيع الثاني

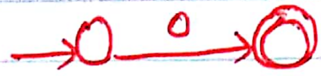
25 THURSDAY
٨ ربيع الثاني

③ $(FA_1)^* = FA_3$



Example (Building NFA-Λ for a regular expression $(00+1)^*(10)^*$)

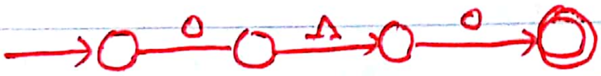
1-



$R_1 = 0$

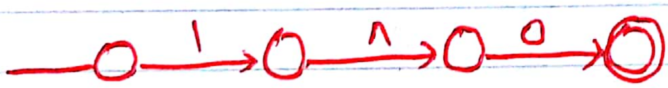
$R_2 = 1$

2-



$R_3 = R_1 R_1 = 00$

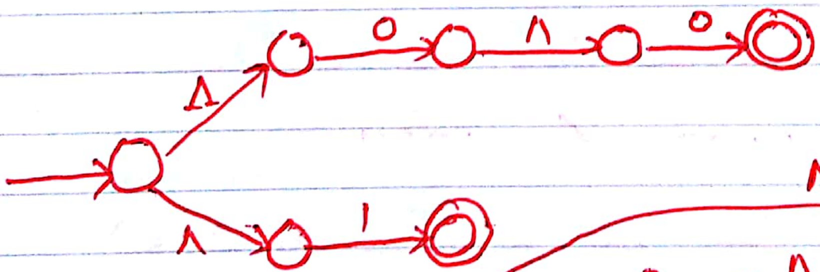
and



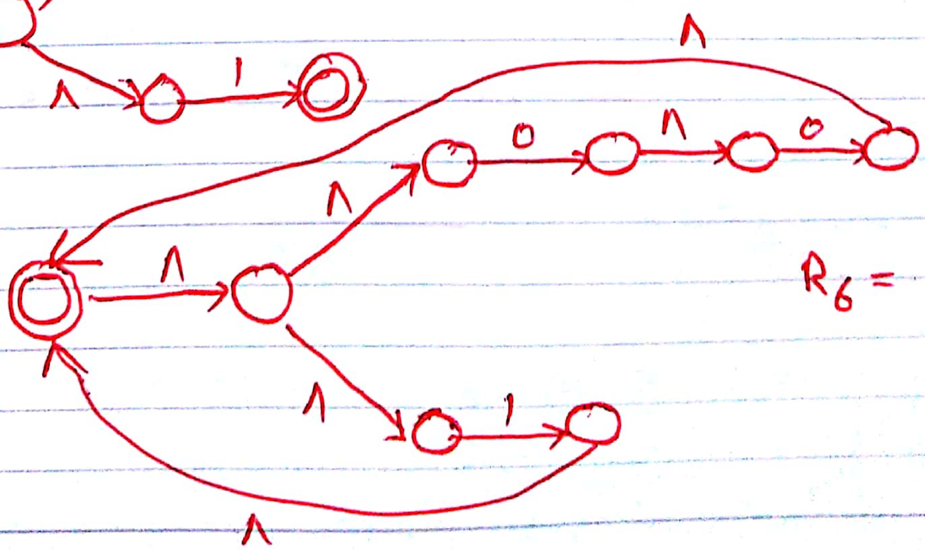
$R_4 = R_2 R_1 = 10$

3-

$R_5 = R_3 + R_2$



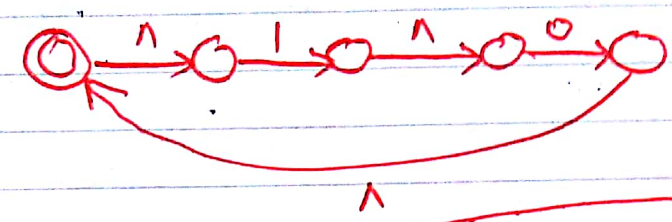
4-



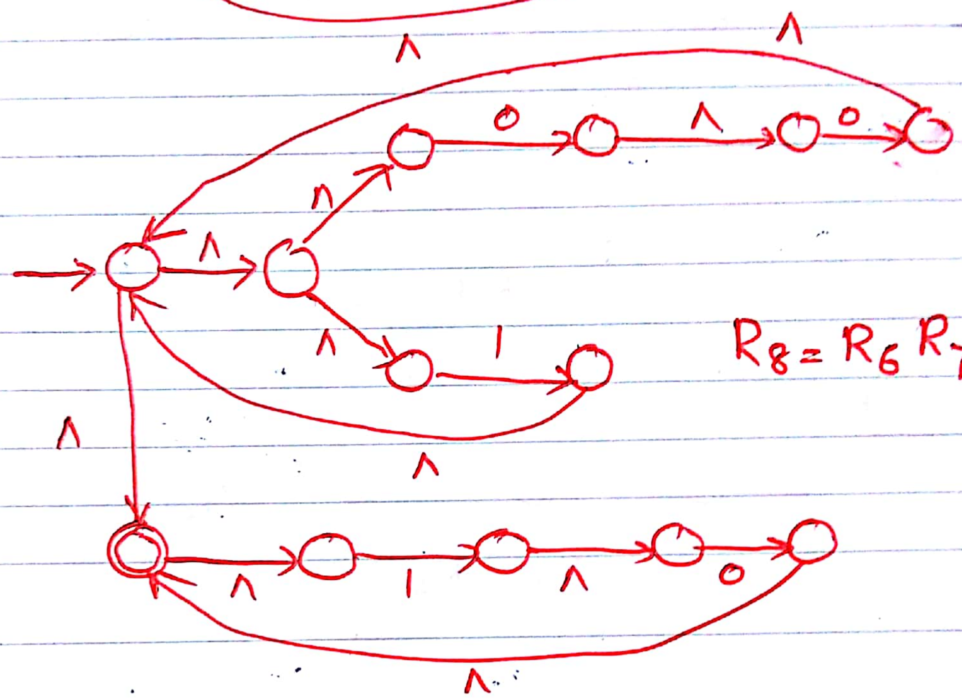
$R_6 = R_5^*$

$R_7 = R_4^*$

5 -



6 -



$R_8 = R_6 R_7$

29 MONDAY ١٢ ربيع الثاني

30 TUESDAY ١٣ ربيع الثاني

This whole process then can be simplified through removing extra 'Λ' edges

(can be seen in the book)