Question-1:

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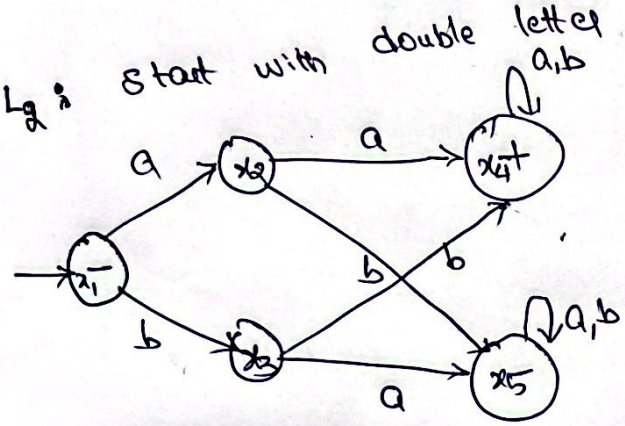
$L_1 \cap L_2$, and $L_1 \cup L_2$

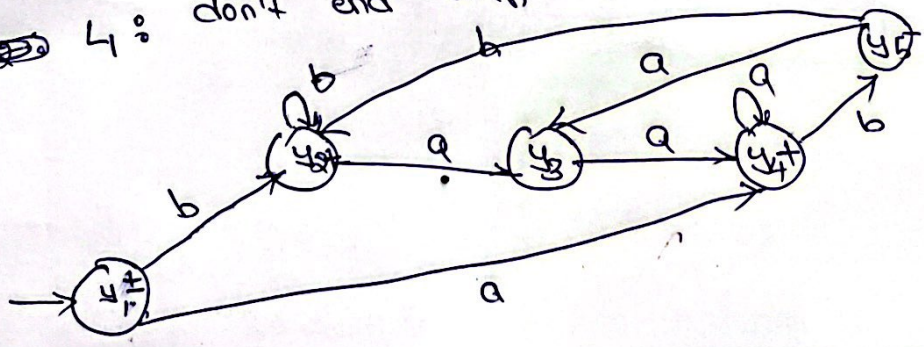
* Two states from both automata need to be considered as starting/initial states
* final states the combination of both states from the two finite automata

L_2 : start with double letter



Regular Expression = $\delta(aa+bb)(a+b)^*$

L_1 : don't end with ab (or) ba



Regular Expression = $\epsilon + a + b + (a+b)^*(aa+bb)$

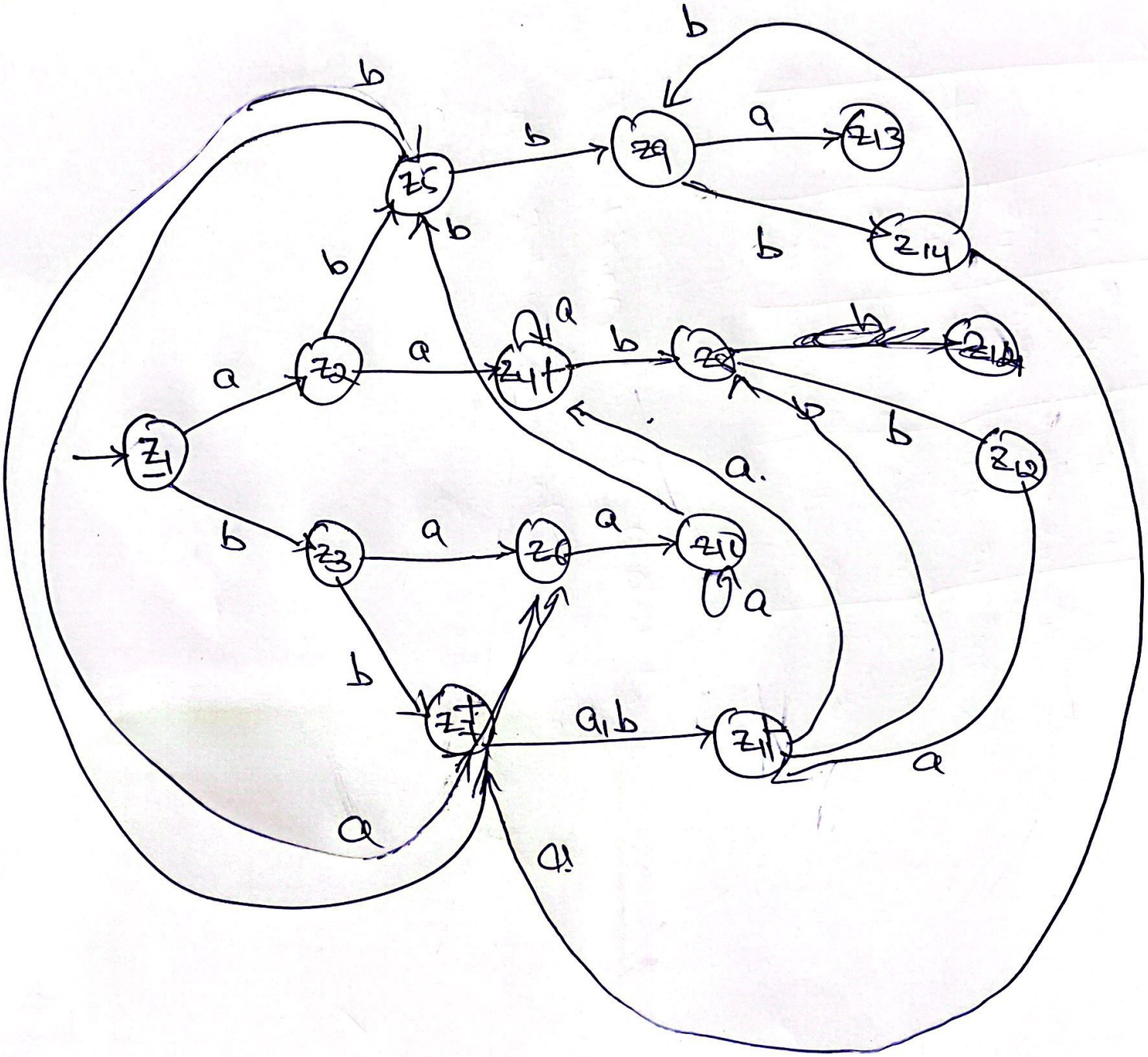
Transition Table:

U	∩	New State		Input a	Input b
+	−	z_1	$x_1 y_1$	$x_2 y_4 = z_2$	$x_3 y_2 = z_3$
		z_2	$x_2 y_4$	$x_4 y_4 = z_4$	$x_5 y_5 = z_5$
+		z_3	$x_3 y_2$	$x_5 y_3 = z_6$	$x_4 y_2 = z_7$
+	+	z_4	$x_4 y_4$	$x_4 y_4 = z_4$	$x_4 y_5 = z_8$
		z_5	$x_5 y_5$	$x_5 y_3 = z_6$	$x_5 y_2 = z_9$
		z_6	$x_5 y_3$	$x_5 y_4 = z_{10}$	$x_5 y_5 = z_5$
+	+	z_7	$x_4 y_2$	$x_4 y_3 = z_{11}$	$x_4 y_3 = z_{11}$
+		z_8	$x_4 y_5$	$x_4 y_3 = z_{11}$	$x_4 y_2 = z_{12}$
+		z_9	$x_5 y_2$	$x_5 y_3 = z_3$	$x_5 y_2 = z_{14}$
+		z_{10}	$x_5 y_4$	$x_5 y_4 = z_{10}$	$x_5 y_5 = z_5$
+		z_{11}	$x_4 y_3$	$x_4 y_4 = z_4$	$x_4 y_5 = z_8$
+	+	z_{12}	$x_4 y_2$	$x_4 y_3 = z_{11}$	$x_4 y_2 = z_7$
		z_{13}	$x_5 y_3$	$x_5 y_4 = z_{10}$	$x_5 y_5 = z_5$
+		z_{14}	$x_5 y_2$	$x_5 y_3 = z_6$	$x_5 y_2 = z_9$

U = Union of L_1 and L_2

∩ = Intersection of L_1 and L_2

$L_1 \cap L_2$



L₁ ∪ L₂