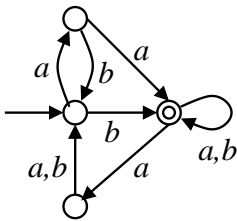


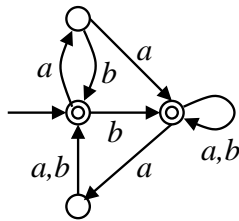
Roll no: _____ Name: _____

[Write your answers in the question paper itself. Be brief and precise. Answer all questions.]

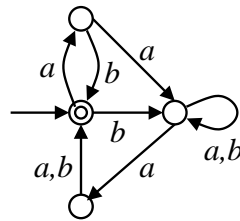
1. From the following four NFAs and four regular expressions, identify the equivalent pairs. (6)



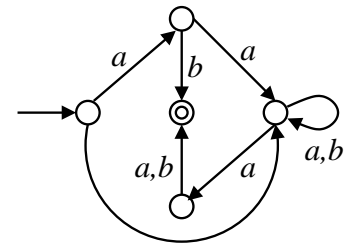
N_1



N_2



N_3



N_4

$$\alpha_1 = ab + (aa + b)(a + b)^*a(a + b)$$

$$\alpha_2 = (ab + (aa + b)(a + b)^*a(a + b))^*$$

$$\alpha_3 = (ab + (aa + b)(a + b)^*a(a + b))^*(aa + b)(a + b)^*$$

$$\alpha_4 = (ab + (aa + b)(a + b)^*a(a + b))^*(\epsilon + (aa + b)(a + b)^*)$$

The NFA N_1 is equivalent to the regular expression _____.

The NFA N_2 is equivalent to the regular expression _____.

The NFA N_3 is equivalent to the regular expression _____.

The NFA N_4 is equivalent to the regular expression _____.

2. Consider the following four context-free grammars over the alphabet $\{a, b\}$ and with the start symbol S .

$$S \rightarrow aaS \mid Sbb \mid \epsilon$$

Grammar G_1

$$S \rightarrow aaSSb \mid aSSbb \mid \epsilon$$

Grammar G_2

$$S \rightarrow aSb \mid bSa \mid \epsilon$$

Grammar G_3

$$S \rightarrow aSb \mid bSa \mid a \mid b$$

Grammar G_4

For each of the following strings, there is a unique grammar among the above four, which generates the string. Identify these respective grammars. (6)

The string $aabbaabb$ is generated by the grammar _____.

The string $aabbbbbb$ is generated by the grammar _____.

The string $aabbbaabb$ is generated by the grammar _____.

The string $aabbaabbb$ is generated by the grammar _____.

3. Let L_1 and L_2 be regular languages over the alphabet Σ . Define the language

$$L_3 = \{\alpha\beta\gamma \mid \alpha\gamma \in L_1, \beta \in L_2\},$$

that is, L_3 is obtained by inserting strings in L_2 inside strings in L_1 . Prove that L_3 is regular too.

(6)

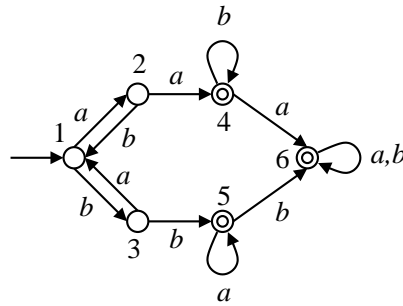
4. Consider the following language over $\Sigma = \{a, b, c\}$:

$$L = \{xcy \mid x, y \in \{a, b\}^*, \#a(x) = \#b(y)\}.$$

Using the pumping lemma, prove that L is not regular.

(6)

5. Consider the following DFA.



Use the DFA state-minimization procedure to convert this DFA to an equivalent DFA with the minimum possible number of states. Also draw the quotient automaton. **(6)**