Name: Anvit Gupta Enroll: 22114009

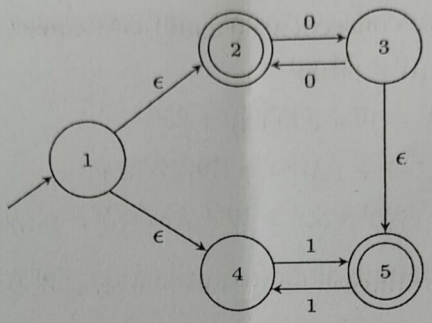
Indian Institute of Technology Roorkee
Department of Computer Science & Engineering
Theory of Computation (CSN-353)
Mid-Term Exam, Date: Sept 11, 2024

Timing: 7:30 to 9:15 AM Max mark: 30

Attempt all questions

Part A: Multiple Choice Questions (2 marks each)

1. Let M be the 5-state NFA with ϵ-transitions shown in the diagram below.



A. $(00)^* + 1(11)^*$
B. $0^* + (1 + 0(00)^*)(11)^*$
C. $(00)^* + (1 + (00)^*)(11)^*$
D. $0^+ + 1(11)^* + 0(11)^*$

2. Consider the following two regular expressions over the alphabet $\{0, 1\}$:

$$r = 0^* + 1^*$$
$$s = 01^* + 10^*$$

The total number of strings of length less than or equal to 5, which are neither in r nor in s, is _____.

A. 44
B. 55
C. 66
D. 33

3. In some programming languages, an identifier is permitted to be a letter followed by any number of letters or digits. If L and D denote the sets of letters and digits, respectively, which of the following expressions defines an identifier?

   A. $(L + D)^+$

   B. $(L \cdot D)^*$

   C. $L(L + D)^*$

   D. $L(L \cdot D)^*$

4. Which one of the following regular expressions represents the language: the set of all binary strings having two consecutive 0's and two consecutive 1's?

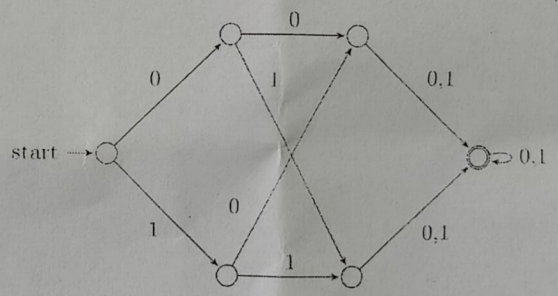
   A. $00(0 + 1)^*11 + 11(0 + 1)^*00$

   B. $(0 + 1)^*00(0 + 1)^* + (0 + 1)^*11(0 + 1)^*$

   C. $(0 + 1)^*(00(0 + 1)^*11 + 11(0 + 1)^*00)(0 + 1)^*$

   D. $(0 + 1)^*00(0 + 1)^*11(0 + 1)^* + (0 + 1)^*11(0 + 1)^*00(0 + 1)^*$

5. Consider the following deterministic finite automaton (DFA).



   The number of strings of length 8 accepted by the above automaton is _____.

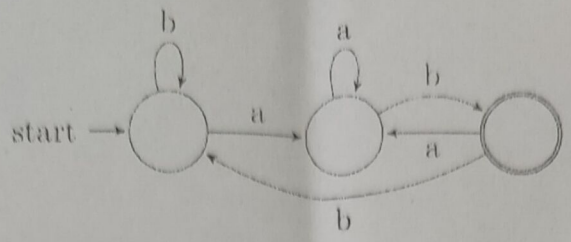
   A. 32

   B. 256

   C. 64

   D. 512

6. If the final states and non-final states in the DFA below are interchanged, then which of the following languages over the alphabet $\{a, b\}$ will be accepted by the new DFA?



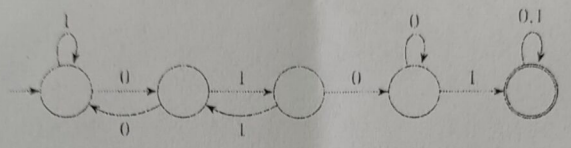
A. The set of all strings that do not end with ab

B. The set of all strings that begin with either an a or a b

C. The set of all strings that do not contain the substring ab

D. The set described by the regular expression $b^*aa^*(ba)^*b^*$

7. Consider the following Deterministic Finite Automaton M.



Let S denote the set of eight-length bit strings whose second, third, sixth, and seventh bits are 1. The number of strings in S that are accepted by M is

A. 0

B. 1

C. 2

D. 3

8. Consider the two regular expressions $\alpha = (0^*10^*)^*$ and $\beta = ((11^*) + (00^*))^*$. Which of the following statements is true?

A. α and β are equivalent.

B. α and β are not equivalent because 010101 is matched by α but not by β.

C. α and β are not equivalent because 101010 is matched by β but not by α.

D. α and β are not equivalent because 000000 is matched by β but not by α.

9. Let N be an NFA with n states. Let k be the number of states of a minimal DFA that is equivalent to N. Which one of the following is necessarily true?

A. $k \geq 2^n$

B. $k \geq n$

C. $k \leq n$

D. $k \leq 2^n$

10. Let L_1, L_2 be two regular languages and L_3 a language which is not regular. Which of the following statements is/are always TRUE?

    A. $L_1 = L_2$ if and only if $L_1 \cap \overline{L_2} = \emptyset$

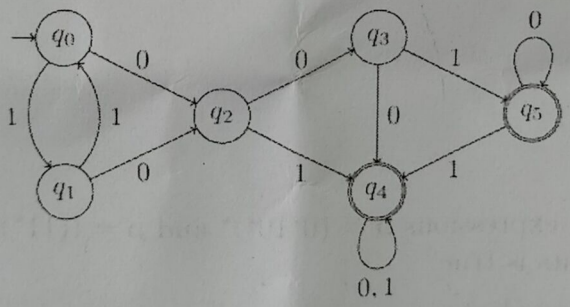
    B. $L_1 \cup L_3$ is not regular

    C. $\overline{L_3}$ is not regular

    D. $\overline{L_1} \cup \overline{L_2}$ is regular

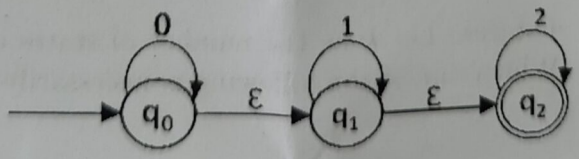
Part B: Subjective Questions

1. Construct the minimum DFA that is equivalent to the given DFA using the Myhill-Nerode theorem, showing the steps of the construction clearly.



Marks: 5

2. Convert the NFA with ϵ-transitions into its equivalent DFA. Show all the transition states.



Marks: 5