National University of Computer and Emerging Sciences

SOLUTION PAPER

Theory of Automata (CS3005)

Sessional-I Exam

Total Time: 1 Hour
Total Marks: 35
Total Questions: **04**

Date: March 1st 2024

Course Instructor(s)

Dr. M. Shahzad, Dr. Nasir-uddin, Mr. Syed Faisal Ali, Ms. Shaharbano, Ms. Bakhtawar, Mr. Mujtaba Ahmed, Ms. Zain Noreen

Semester: SP-2024
Campus: Karachi
Dept: Computer Science

Student Name	Roll No	Section	Student Signature
_____	_____	_____	_____

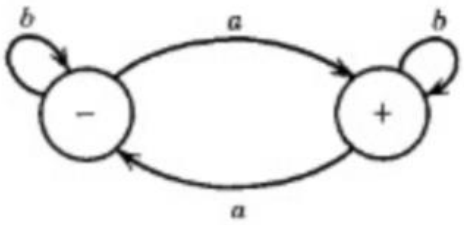
CLO 1: Explain and manipulate the different concepts in automata theory and formal languages such as formal proofs, automata, regular expressions, and Turing machines.

Q1: Deterministic Finite Automata (DFA) **[3+12 marks]**

a) Construct DFAs for the following regular expressions:

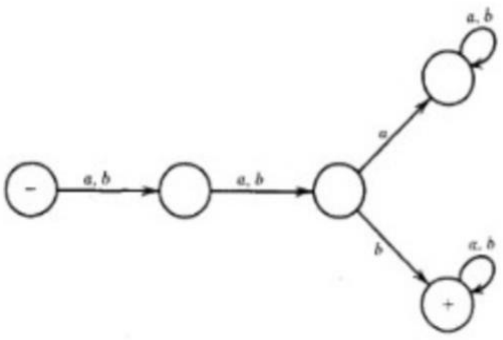
i. b*a(b*ab*ab*)*

Solution:



ii. (aab + abb + bab + bbb)(a + b)*

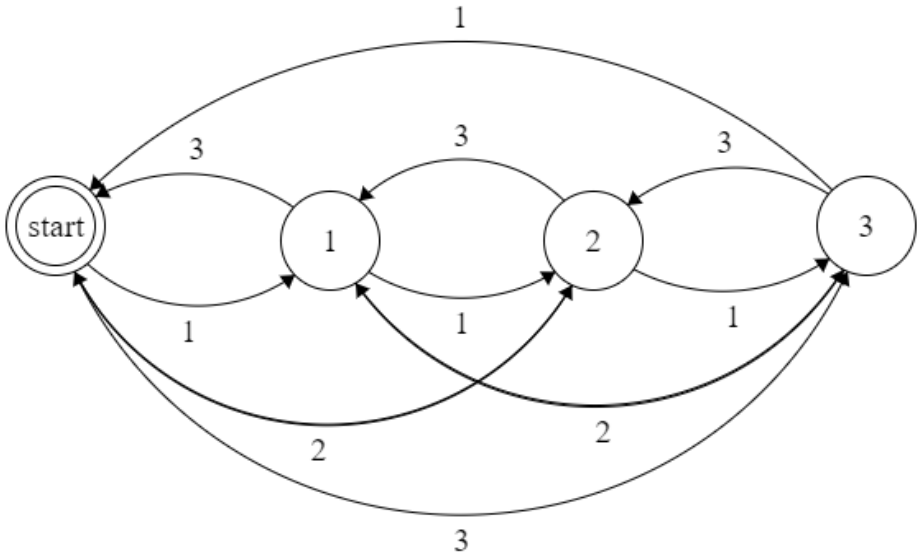
Solution:



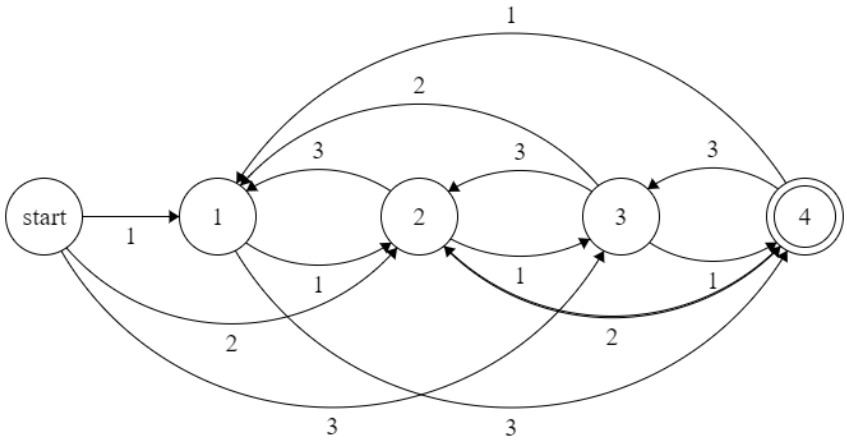
b) Provide the DFA for a vending machine that accepts multiples of **4** rupees. The machine will only accept rupees of coin **1**, coin **2,** and coin **3** as input letters at any state, i.e., **∑ = {1, 2, 3}**. The following are a few samples of accepted and rejected strings for this vending machine:

- - Ɛ (reject)
- - 22 (accept)
- - 1222 (reject)
- - 1222221111 (reject)
- -31 (accept)
- - 1111 (accept)
- - 3333 (accept)

Solution 1:



Solution 2:



CLO 3: Design of automata, RE and CFG

Q2: Regular Expressions (REs) **[5+5 marks]**

a) Give the RE to Identify a student's e-mail ID at Karachi, Lahore & Islamabad Campuses of FAST-NUCES. Student IDs at the Karachi campus start with the letter *K*, while the Lahore campus IDs start with the letter *L,* and the letter *I* is used for the Islamabad campus.

Some accepted strings are: 21K-1990, 19I-1000, 18L-2023.

Solution:

```
(0-9)(0-9)(K+I+L)(-)(0-9)(0-9) (0-9)(0-9)
```

OR

```
[0-9]{2}[KIL]-[0-9]{4}
```

b) Write a regular expression that identifies file names along with their file extensions. File names may include letters (A-Z, a-z), numbers (0-9), and specific special characters such as hyphens (-) and underscores (_). The accepted file extensions are limited to: .txt, .docx, .pdf, and .jpeg

Solution:

```
(A-Za-z_0-9-)+(.)(txt+docx+pdf+jpeg)
```

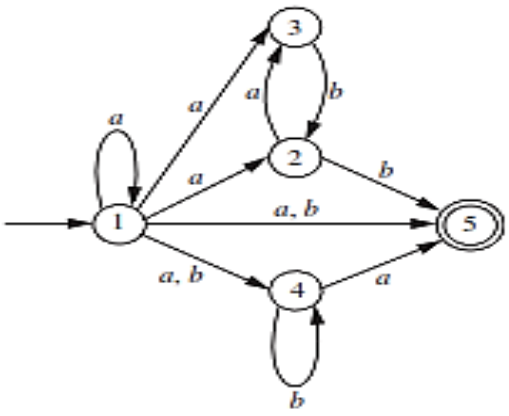
OR

```
[A-Za-z0-9-]+(\.)((txt)|(docx)|(pdf)|(jpeg))
```

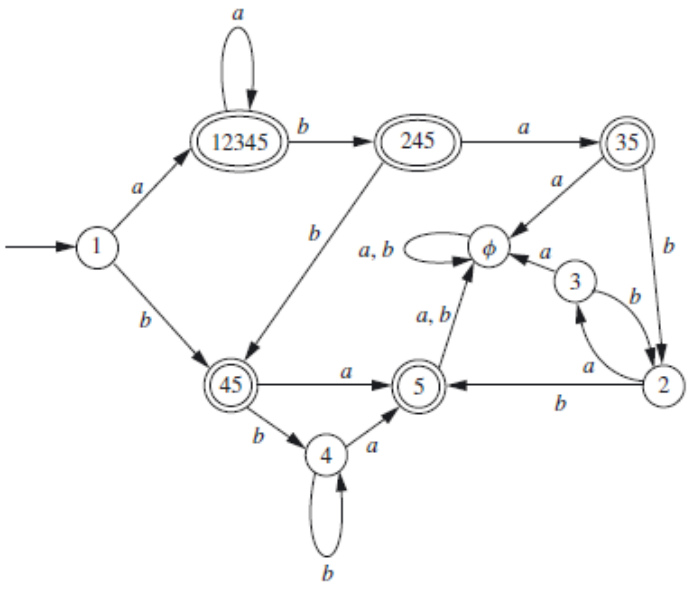
CLO 4: Transform between equivalent NFA-Null, NFA and DFA.

Q3: Conversion NFA to DFA **[5 marks]**

For the given below NFA convert it into an equivalent DFA. Also, show three accepted and rejected strings.



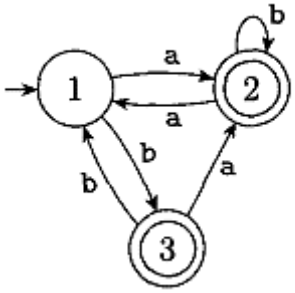
Solution:



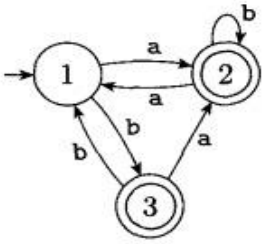
CLO 1: Explain and manipulate the different concepts in automata theory and formal languages such as formal proofs, automata, regular expressions, Turing machines.

Q4: Kleene's Theorem **[5 marks]**

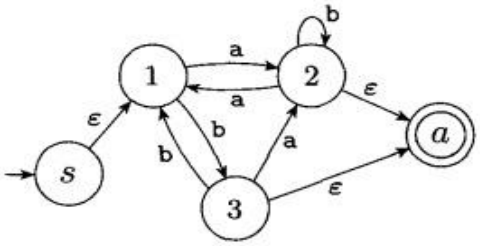
Drive the regular expression for the language accepted by the following NFA. For full credit show all the steps clearly. Σ={a,b}. {Hint: Use state elimination method]



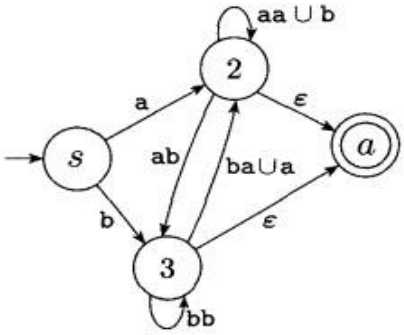
Solution:



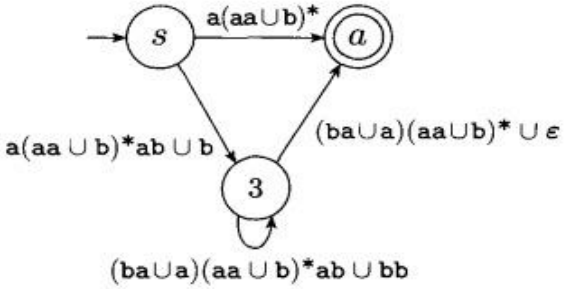
(a)



(b)



(c)



(d)

(a(aa∪b)*ab∪b)((ba∪a)(aa∪b)*ab∪bb)*((ba∪a)(aa∪b)* ∪ε)∪a(aa∪b)*

(e)