CS 30: Theory of Automata
Midterm Exam 1 Solutions

QUESTION 1 **Marks: 20**

i. Tick all regular expressions which express
L = {w | w ∈ {0,1}* and w has no consecutive 0 and no consecutive 1}
a. (10)*+(01)*
b. (10 + 01)*
c. (0(10)* + 1(01)*)*
d. ((01)*0 + (10)*1)*
ANSWER: None of these answers are correct

ii. Tick all regular expressions which express
L = {w | w ∈ {0,1}* and length of w is at least 2 and w does not end with 10}
a. (0+1)*(00 + 11 + 01)
b. (0+1)*((00)* + (11)* + (01)*)
c. 0*(00 + 11 + 01) + 1*(00 + 11 + 01)
d. (0+1)*((0+1)1) + (0+1)*00
ANSWER: a,d

iii. Write down all strings of the language given by the regular expression: (1+010+ε)(0+ε)
{0,010,0100,1,10, ε}

iv. Write down the first three shortest strings that belong to: L = $\{(a^k b^k)^k \mid k > 1\}$
{aabbaabb, aaabbbaaabbbaaabbb, aaaabbbbaaaabbbbaaaabbbbaaaabbbb}

v. Is it possible that for any language (denoted by L) L*=L? If so what is L? **Yes, L = {ε}**

vi. Suppose $L_1 = \phi$ $L_2 = \{a,b,c\}$ then $L_1L_2 =$ ϕ

For parts vii-x consider the NFA machine M of Figure 1.

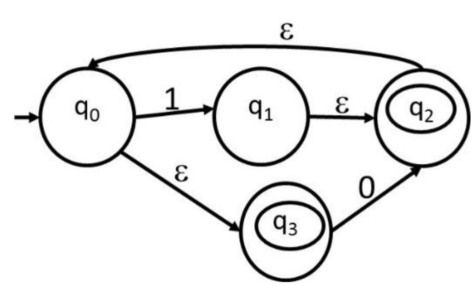

Figure 1: NFA-ε Machine M

vii. What is $\delta^*(q_1,1)$ for M? **$\{q_0,q_1,q_2,q_3\}$**

viii. What is $\delta^*(q_0,11)$ for M? **$\{q_0,q_1,q_2,q_3\}$**

ix. What is the null closure $\varepsilon\{q_0,q_1\}$? **$\{q_0,q_1,q_2,q_3\}$**

x. When ε transitions are removed from M to make an NFA without any null transitions, then what is the set of final states? **Answer: $\{q_0, q_2,q_3\}$**

QUESTION 2 **Marks: 5**

Construct a DFA using the method of subset construction from the following NFA machine N. Only fill out the given **state transition table** of the resulting DFA. No additional working is required.

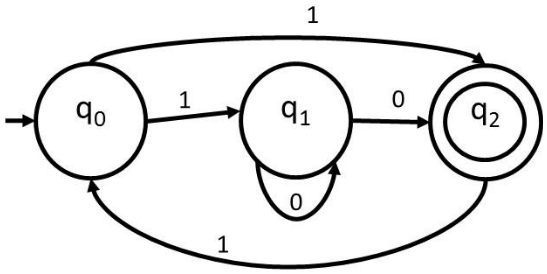

Figure 2: NFA Machine N

State	0	1
→ $\{q_0\}$ * $\{q_1,q_2\}$	ϕ $\{q_1,q_2\}$	$\{q_1,q_2\}$ $\{q_0\}$

QUESTION 3 **Marks: 5**

Make a state transition diagram for a DFA for:

L = {w | w ∈ {0,1}* and w has at least one 0 and at least one 1}