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Answer 1

a)

False. $\sum^*$ stands for all possible strings on $\sum$. Since we can map all strings to natural numbers by their length, $\sum^*$ is countable, but we know that real numbers are uncountable. Therefore we cannot represent real numbers by this alphabet.

b)

False. $\sum^*$ is countable, but it's infinitely countable. $\sum^*$ can be an alphabet, but we cannot represent it finitely.

c)

True. With kleen star operand can concatenate by itself any number of time including 0. It means we can have empty string after operation. If we 0 for first a, 2 for first b, 1 for second a, and 0 for second b, we can obtain "bba". Therefore "bba" $\in$ a*b*a*b*.

d)

False. With "+" operator we can obtain a string with length 1 at least. It's true that we can have a prefix "ab", but it can be for instance "aab" or "aaab" and so on. Therefore it's not a neccesity to have a prefix "ab".

Answer 2

a)

K : q_0, q_1, q_2, q_3
$\sum$: a,b
s : q_0
F : q_0, q_1, q_2

δ : $((q_0, a), q_1), ((q_0, b), q_0), ((q_1, a), q_1), ((q_1, b), q_2), ((q_2, a), q_3), ((q_2, b), q_0), ((q_3, a), q_3), ((q_3, b), q_3)$

and q_3 is trap state. Basically machine waiting when it sees consecutive a's. It's returning starting state when 'b' comes after "ab", and reaching trap state when there is a "aba" as a substring.

b)

(q_0, abbaabab), (q_1, bbaabab), (q_2, baabab), (q_0, aabab), (q_1, abab), (q_1, bab), (q_2, ab), (q_3, b), (q_3, e)

Since q_3 is trap state and not a final state, input is not accepted.

Answer 3

a)

E(q) means that set of all the states which is reachable from q with empty transitions. According to this:
E(q_0) = $\{q_0, q_2\}$
E(q_1) = $\{q_1\}$
E(q_2) = $\{q_2\}$
E(q_3) = $\{q_0, q_2, q_3\}$
E(q_4) = $\{q_0, q_2, q_3, q_4\}$

b)

1^{st} step: This step is correct. We say that K' = 2^K which means power set.

2^{nd} step: This step is correct as well. There will be no other input for machine. Since we are constructing DFA, for every state we must evaulate all possible input from alphabet. Therefore alphabet must be same as NFA for DFA.

3^{rd} step: For DFA starting state contains all states from E(q) where q is starting state. Question says that startnig state does not have any empty transitions. Therefore E(q) equals to {q}. This step is correct.

4^{th} step: This step is incorrect. In DFA final states will be the sets which contain final states from NFA.

5^{th} step: It's correct. We are starting with considering E(q)'s, and we find δ function results of this sets until a empty set. This q's have a $\triangle$ relation, and union of these is (Q) subset of K'.