DI32003 - Theory of Computation

Year 24/25 Final Questions Recall

Time allowed: 2 hrs

Note that since this is a recall of the questions, some content cannot be provided. This will result in the inability to answer **Q1**, **Q2 b)** and **Q9**. Please pay more attention to the examination format of these questions and the knowledge points involved.

By WaterCoFire

1. Consider a given DFA M. For all states q_0, q_1, q_2, q_3, q_4 in M, write a string such that M ends up in that state after processing the string.
   (Note: Since this is a recall, the transition diagram of M is omitted.)
2. a) Explain how to convert a NFA-ϵ to a standard NFA.
   b) Consider the given NFA-ϵ M. Illustrate your idea by converting it to a standard NFA M'.
   (Note: Since this is a recall, the transition diagram of M is omitted.)
3. Consider the regular language L. Prove that $L^2 = \{w_1w_2 | w_1 \in L, w_2 \in L\}$ is regular. You may not directly use the properties of regular languages to prove this.
4. Consider the regular expressions $(rs)^*$ and r^*s^*. Are these two regular expressions the same? Please provide proof or a counterexample.
5. a) Describe the Pumping Lemma.
   b) Prove that $L = \{0^n1^m | n > m\}$ is not regular.
6. Consider the language $L = \{0^i1^i2^i | i > 0\}$.
   a) Give an implementation-level description of a one-way TM that accepts this language.
   b) Explain how a 2-tape TM can accept this language faster.
7. Consider languages L_1, L_2, L_3 and TMs M_a, M_b, M_c, M_d. It is known that M_a and M_b do not halt on all inputs, while M_c and M_d halt on all inputs, and $L_1 = L(M_a) = L(M_c)$, $L_2 = L(M_b)$, $L_3 = L(M_d)$. Please indicate which of the languages L_1, L_2, L_3 are:
   a) Partially decidable?
   b) Totally decidable?
   c) Impossible to determine whether it is partially decidable or totally decidable?
   And give your explanations.
8. a) Define the NP class.
   b) Define the NP-Complete class.
   c) What is the relationship between these two classes?
9. Consider six unknown languages A, B, C, D, E, F, a NP-Complete language L_1, and a language L_2 in class P. Based on the given polynomial-time reduction relations between them, determine the complexity classes to which A, B, C, D, E, F belong.
   (Note: Since this is a recall, all reduction relations are omitted. There are approximately 8 reduction relations, e.g., $B \propto L_1$, $A \propto C$, etc. $A, B, C, D, E, F, L_1, L_2$ all have their own names in the original problem, such as $Horse$, $Camel$, etc., but these are their aliases here.)