香 港 中 文 大 學
The Chinese University of Hong Kong

二零一三至一四年度上學期科目考試
Course Examination 1st Term, 2013 – 2014

科目編號及名稱
Course Code & Title : CSCI 3130 Formal Languages and Automata Theory

時間　　　　　　　　　　　小時　　　　　　　分鐘
Time allowed : 2 hours 0 minutes

學號　　　　　　　　　　　　　　座號
Student I.D. No. : _____ Seat No. : _____

1. Consider the regular language L over $\Sigma = \{0, 1\}$:

   $L = \{w \mid w$ does not contain "000"$\}$

   (a) Give a regular expression for L. (4%)
   (b) Draw a DFA for L. (5%)
   (c) Consider $L_1 = \{w \mid w \in L$ and w ends with "00"$\}$. Is L_1 regular? Prove your answer. (8%)
   (d) Consider $L_2 = \{w \mid xwy \in L$ for some $x, y \in (0+1)^*\}$. Is L_2 regular? Prove your answer. (8%)

2. Consider the following grammar over $\Sigma = \{a, b\}$:

   $G: \quad S \to AABB$
   $A \to AA \mid a$
   $B \to BB \mid b$

   (a) Give a rightmost derivation of the string "$aaabbb$" using G. (3%)
   (b) Give the parse tree of the derivation in part (a). (3%)
   (c) Suggest what the language L of grammar G is. (3%)
   (d) Write G in Chomsky Normal Form G_1. (4%)
   (e) Show that G is ambiguous. (6%)
   (f) Give an unambiguous grammar G_2 for L. Explain briefly why G_2 is unambiguous. (6%)
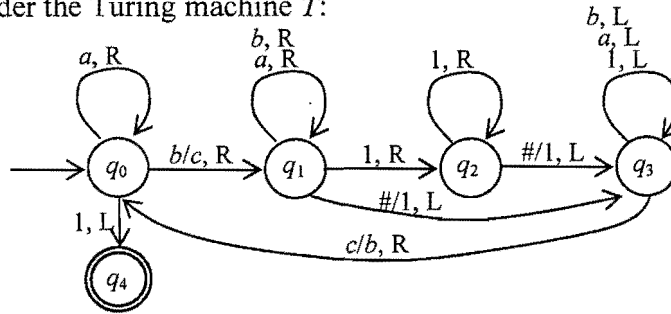
3. Consider the following languages:

   $L_1 = \{k \mid$ Turing machine T_k will halt on input "010" in ten steps$\}$
   $L_2 = \{k \mid$ Turing machine T_k will halt on input "010"$\}$

   (a) Is L_1 recursive? Explain your answer. (8%)
   (b) Is L_2 recursively enumerable? Explain your answer. (8%)
   (c) Is L_2 recursive? Explain your answer. (8%)

4. Consider the Turing machine T:

(a) What will be the *final* tape content for input "*abaab*"? Where will be the pointer when T halts? (5%)

(b) Suggest what does T do on a string from $(a+b)^*$ with at least one b? (5%)

(c) Construct an MPCP instance $I = (A, B)$ such that I has a solution if and only if T accepts the input string "*aba*". (8%)

(d) Does I have a solution? Give the sequence of indices used in the construction of the solution if yes. Explain why a solution does not exist otherwise. (8%)

End of Paper