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

Course Examinations 1998 - 99

Course Code & Title : CSC3130 Formal Languages and Automata Theory

Time allowed : 2 hours - minutes

Student I.D. No. : Seat No. :

Answer all three (3) questions.

1. (a) **(15 marks)** Construct a Turing machine M = (Q, T, P, q_I) that computes the function f:T*→T* defined by

$$f(a\omega) = \omega a$$

where $a \in T$ and $\omega \in T^*$.

(b) **(15 marks)** Show that it is undecidable whether a Turing machine halts on the string *aaa*. Assume that its set of tape symbols is $\{a, b, c\}$.

(c) **(5 marks)** Is it a decidable problem to determine whether a language is recursive? Justify your answer.

2. (a) (i) **(5 marks)** Define 'recursive languages' and 'recursively enumerable languages.'

(ii) **(5 marks)** Explain the relation, if any, between recursive languages and decidable problems.

(iii) **(10 marks)** Let ω(M) be the string that uniquely represents a Turing machine M and L(M) be the set of strings accepted by M. Let $\Omega = \{\omega(M) \mid L(M) = \varnothing\}$. Is Ω a recursive language? Is Ω a recursively enumerable language? Justify your answers.

(b) **(15 marks)** Consider the Turing machine M = (Q, T, P, q_I) with the following specification.

$Q = \{q_1, q_2, q_3\}$
$T = \{a, b\}$
$P = \{q_1: \text{right}(a/a, q_1),$
$q_1: \text{right}(b/b, q_2),$
$q_2: \text{left}(\#/\#, q_3),$
$q_2: \text{left}(a/b, q_1),$
$q_2: \text{left}(b/a, q_2)\}$
$q_I = q_1$

Construct a type 0 grammar that generates the language accepted by M.

3. Consider the following CFG.

$S' \rightarrow S$

$S \rightarrow aSa \mid bSb \mid cd$

(a) **(5 marks)** Write down the set of all *LR*(0) items of this grammar.

(b) **(15 marks)** Construct a DFA that accepts the language of all viable prefixes.

(c) **(10 marks)** Is this grammar *LR*(0)? If it is, show all the steps how the string *abcdba* can be parsed. If it is not, explain why.

- End of Paper -