香 港 中 文 大 學

The Chinese University of Hong Kong

二0一四至一五年度上學期科目考試

Course Examination 1st Term, 2014-15

科目編號及名稱
Course Code & Title : CSCI3130 Formal Languages and Automata Theory

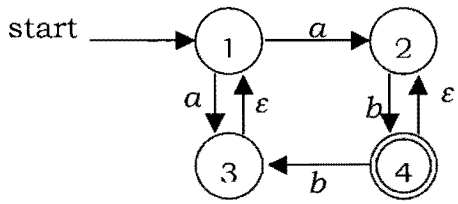
時間 小時 分鐘
Time allowed : 2 hours _____ minutes

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

Answer all questions.

1. **(10 marks)** Let $n_a(\omega)$ denote the number of occurrences of symbol a in string ω, and $n_b(\omega)$ the number of occurrences of symbol b in string ω. Is the language
$$\{\omega \mid \omega \in \{a,b\}^*, n_a(\omega) = n_b(\omega)\}$$
regular? Prove your answer.

2. Consider the following ε-NFA.



   a. **(10 marks)** Convert the ε-NFA to a DFA.
   b. **(10 marks)** Give a regular expression that is equivalent to the ε-NFA.

3. Consider the following language.
$$\{a^i b^j c^k \mid 0 < j < i, j = i + k\}$$
(10 marks) Is the language context free? Prove your answer.

4. **(10 marks)** Prove that the following language is not context free.
$$\{a^i b^{2i} c^j \mid 0 < j < i\}$$

5. A CFG (with E as its start symbol) and its SLR parsing table are shown below.

(1) $E \rightarrow E+T$ (4) $T \rightarrow F$
(2) $E \rightarrow T$ (5) $F \rightarrow (E)$
(3) $T \rightarrow T*F$ (6) $F \rightarrow$ **id**

STATE	ACTION						GOTO		
	id	+	*	(	)	$	E	T	F
0	s5			s4			1	2	3
1		s6				acc			
2		r2	s7		r2	r2			
3		r4	r4		r4	r4			
4	s5			s4			8	2	3
5		r6	r6		r6	r6			
6	s5			s4				9	3
7	s5			s4					10
8		s6			s11				
9		r1	s7		r1	r1			
10		r3	r3		r3	r3			
11		r5	r5		r5	r5			

Figure 4.37: Parsing table for expression grammar

(Source: Aho, Lam, Sethi & Ullman, *Compilers: Principles, Techniques, and Tools* (2nd Edition). Addison-Wesley.)

a. **(10 marks)** Copy the following table to the answer book, and show using the copied table the process of parsing the string '**id** * (**id**)' using the parsing table above.

	STACK	SYMBOLS	INPUT	ACTION
(1)			**id** * (**id**) $	
(2)				

b. Consider the following CFG, in which S is the start symbol.

(1) $S \rightarrow i\,B\,t\,S\,e\,S$
(2) $S \rightarrow a$
(3) $B \rightarrow$ **id**

i. **(10 marks)** Give a PDA that accepts the language of this CFG.
ii. **(10 marks)** Define the FIRST and FOLLOW functions for this CFG.
iii. **(10 marks)** Is this grammar LL(1)? Justify your answer.

6. **(10 marks)** Despite the existence of the halting problem, we know that some Turing machines do halt on some particular inputs. Let H denote the set $\{\langle T,i\rangle \mid T$ is a Turing machine that halts on input $i\}$. Discuss whether or not the following problem is decidable: given any Turing machine X, whether or not there exists input a such that $\langle X,a\rangle \in H$.

— End of Paper —