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

Course Examination 1st Term, 2010 - 2011

Course Code & Title : **CSCI 3130: Formal languages and automata theory**

Time allowed : **2 hours**

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

Questions 1–2: _____

Questions 3–4: _____

Questions 5–6: _____

Questions 7–8: _____

Questions 9–10: _____

Total: _____

The exam consists of 10 questions, worth 10 points each. In each of the questions you are given a statement with a true/false choice. Circle one of the choices and explain your answer. It is always to your advantage to circle a choice *and* explain your answer.

Possibly useful facts:

$A_{\text{TM}} = \{ \langle M, w \rangle : \text{TM } M \text{ accepts input } w \}$ is not decidable.

$SOME_{\text{TM}} = \{ \langle M \rangle : \text{TM } M \text{ accepts some input} \}$ is not decidable.

$ALL_{\text{CFG}} = \{ \langle G \rangle : \text{CFG } G \text{ generates all inputs} \}$ is not decidable, even if G has alphabet $\{0, 1\}$.

$CLIQUE = \{ \langle G, k \rangle : \text{Graph } G \text{ has a clique of size } k \}$ is NP-complete.

CSCI 3130

1. The language $L = \{waw^R : w \in \Sigma^*\}$ is **regular** over $\Sigma = \{\mathtt{a}, \mathtt{b}\}$. ($w^R$ is the reverse of w.)

true **false**

2. The following language over $\Sigma = \{\mathtt{a}, \mathtt{b}\}$ has a DFA with **4 states**:

$L = \{w \in \Sigma^* : w \neq \varepsilon$ and w starts and ends with the same symbol.$\}$

true **false**

3. If L is regular over $\Sigma = \{\mathtt{a}, \mathtt{b}\}$ then the following language is **regular** over $\Sigma' = \{\mathtt{a}, \mathtt{b}, \star\}$:

$$L' = \{w_1 \star w_2 \star \ldots w_k \star : w_1 \ldots w_k \in L \text{ and } w_1, \ldots, w_k \in \Sigma\}.$$

true **false**

4. The language $L = \{x\#y : x, y \in \{\mathtt{a}, \mathtt{b}\}^* \text{ and } |x| \neq |y|\}$ is **context-free** over $\Sigma = \{\mathtt{a}, \mathtt{b}, \#\}$.

true **false**

5. The context-free grammar $E \rightarrow E$ + x | x is **LR(0)**.

true **false**

6. There is an **unambiguous** context-free grammar for the language (a*b)*.

true **false**

7. The language $L = \{\langle D \rangle : \text{The language of DFA } D \text{ is } (00 + 11)^*\}$ is **decidable**.

true **false**

8. The language $L = \{\langle G \rangle : \text{The language of CFG } G \text{ is } (00 + 11)^*\}$ is **decidable**.

true **false**

9. The following language is **decidable** (you may assume $\Sigma = \{0, 1\}$):

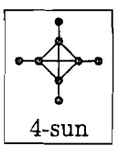
$$L = \{\langle M_1, M_2 \rangle : \text{For some } w \in \Sigma^*, \text{ TMs } M_1 \text{ and } M_2 \text{ both accept } w\}.$$

true **false**

10. A *k-sun* is a graph with $2k$ vertices $\{v_1, \ldots, v_{2k}\}$, where $\{v_1, \ldots, v_k\}$ is a clique and (v_1, v_{k+1}), (v_2, v_{k+2}), $\ldots$, (v_k, v_{2k}) are additional edges.

The language $L = \{\langle G, k \rangle : G \text{ is a graph that contains a } k\text{-sun}\}$ is NP-**complete**.

true **false**



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