

**Comprehensive Examination
Formal Languages
Spring 2011 (B)**

1) (15 points) Circle T (true) or F (false) for each of the following.

- | | | |
|--|---|---|
| The recursively enumerable languages are closed with respect to complementation. | T | F |
| The recursively enumerable languages are close with respect to union. | T | F |
| The recursively enumerable languages are close with respect to intersection. | T | F |
| The recursive languages are closed with respect to complementation. | T | F |
| The recursive languages are close with respect to union. | T | F |
| The recursive languages are close with respect to intersection. | T | F |
| The recursive languages are close with respect to set difference. | T | F |
| The context-free languages are closed with respect to complementation. | T | F |
| The context-free languages are close with respect to union. | T | F |
| The context-free languages are close with respect to intersection. | T | F |
| The regular languages are closed with respect to complementation. | T | F |
| The regular languages are close with respect to union. | T | F |
| The regular languages are close with respect to intersection. | T | F |
| The regular languages are close with respect to set difference. | T | F |
| The intersection of a regular and context-free language is context-free. | T | F |

2) (15 points) Suppose L is a finite language, i.e., contains a finite number of strings over some finite alphabet. For each of the following, be sure to explain your answer.

a) Is L regular?

b) Is L context-free?

c) Is L recursive?

3) (15 points) State the pumping lemma for regular languages.

4) (15 points) Give a DFA, an NFA or and NFA- ϵ that accepts the language $0^*1^*(0+11)^*$. Note that for this question you are not required to perform a formal conversion using any particular technique. Simply giving the DFA or NFA is sufficient.

5) (20 points) For each of the following indicate whether the specified language is (a) regular, (b) context-free but not regular, (c) recursive but not context-free, or (d) non-recursive (note that no proof is required in any case).

a) $\{0^i \mid i \geq 0\}$

b) $\{0^i 1^i \mid i \geq 0\}$

c) $\{0^i 1^i 2^i \mid i \geq 0\}$

d) $\{0^i 1^j 2^j 3^j \mid i, j \geq 0\}$

e) $\{w \mid w \text{ is a valid Turing machine encoding}\}$

6) Consider the following regular expression r .

$$1(0+1)^*0(0+1)^*1$$

(a) (10 points) Circle those strings that are in $L(r)$.

101	1111	0101	0	1010101
ϵ	00100	10011	11	111101

(b) (10 points) In words, describe the language $L(r)$.