

**PART 1 Due: Thursday, Feb. 16, beginning of class**

**PART 2 Due: Thursday, Feb. 16, 11:59PM**

**54 points**

On homework, you may discuss with other students in the course about how to solve a problem, but the write-up should be your own. You **must include the names** of any students you consulted with. Give credit where credit is due. You can use JFLAP to check your answer on many of these problems.

All JFLAP files mentioned below are on [www.jflap.org](http://www.jflap.org).

**PART 1: Written, Bring to class**

1. (8 pts) Prove the following languages are not regular by using **the pumping lemma**. Show all steps.

(a)  $L = \{a^n b^p c^k \mid n > p + k, n > 0, p > 0, k > 0\}$

(b)  $\Sigma = \{a, b, c\}$ ,  $L = \{w \in \Sigma^* \mid n_a(w) * n_b(w) > n_c(w)\}$ , where  $n_x(w)$  means the number of times  $x$  appears in  $w$ .

2. (3 pts) Consider the following proof to prove the following language is not regular.  
 $\Sigma = \{a, c\}$ ,  $L = \{w \in \Sigma^* \mid n_a(w) = 2 * n_c(w)\}$

Explain what is wrong with the proof.

• **Proof:**

Assume  $L$  is regular.

Define the homomorphism  $h(L)$  by  $h(aa) = a$  and  $h(c) = b$ .

$L_2 = h(L) = \{w \in \Sigma^* \mid n_a(w) = n_b(w)\}$ , with  $\Sigma = \{a, b\}$ .  $L_2$  is regular by closure of homomorphism.

$L_3 = \{a^n b^m \mid n \geq 0, m \geq 0\}$ ,  $L_3$  is regular.

$L_4 = L_2 \cap L_3 = \{a^n b^n \mid n \geq 0\}$ ,  $L_4$  is regular by closure of intersection.

$L_5 = L_4 - \{\lambda\} = \{a^n b^n \mid n > 0\}$ ,  $L_5$  is regular by closure of difference.

Contradiction! already shown  $L_5$  is not regular.

Thus,  $L$  is not regular. QED.

3. (4 pts) Prove that the following language is NOT regular by using **closure properties**. Show all steps.

$L = \{a^n b^p c^k \mid n = p + k, n > 0, p > 0, k > 0\}$

4. (6 pts) Problem 1(f) in JFLAP book Chapter 5. List five strings that are accepted, five that are not accepted, and list the language of the NPDA.
5. (5 pts) Problem 1(d) in JFLAP book Chapter 6. List five strings that are accepted and list the language of the CFG.
6. (8 pts) Problem 5 in JFLAP book Chapter 6 (all 4 parts).
7. (4 pts) Problem 6(c) in JFLAP book Chapter 6. Turn in a picture of the NPDA (JFLAP picture or handdrawn).

## **PART 2: Submit online**

Note for some of these you need to write the answers in a file. Call the file README (see below).

1. (4 pts) Problem 5(b) in JFLAP book Chapter 5. Call this NPDA JFLAP file: ch5prob5b
2. (4 pts) Problem 5(c) in JFLAP book Chapter 5. Call this NPDA JFLAP file: ch5prob5c
3. (4 pts) Problem 4(a) in JFLAP book Chapter 6. Call this CFG JFLAP file: ch6prob4a
4. (4 pts) Problem 4(f) in JFLAP book Chapter 6. Call this CFG JFLAP file: ch6prob4f

## **Submitting Part 2**

To submit files, you can use Eclipse. Make sure you select *cps140* and *homework4* for the location to submit.

Submit a README file and all the .jff files at one time. You can submit more than once, if so, we only grade the last submission.

## **JFLAP**

JFLAP is available [www.jflap.org](http://www.jflap.org).