

**Harvard University
Computer Science 121**

Problem Set 5

Due Tuesday, October 22, 2013 at 1:20 PM.

Submit your solutions electronically to `cs121+ps5@seas.harvard.edu` with "ps5 submission" in the subject line. The solutions to Parts A and B should be attached as separate PDF files, called `lastname+ps5a.pdf` and `lastname+ps5b.pdf`.

Late problem sets may be turned in until Friday, October 25, 2013 at 1:20 PM with a 20% penalty.

Problem set by ****ENTER YOUR NAME HERE****

Collaboration Statement: ****FILL IN YOUR COLLABORATION STATEMENT HERE
(See the syllabus for information)****

See syllabus for collaboration policy.

PART B (Graded by Perry)

PROBLEM 1 (3+3+3+3+3 points)

True or false? Justify your answers.

- (A) $\{a^{n^2} : n \geq 0\}$ is context free.
- (B) $\{a^n b^m : n < m < 2n\}$ is context free.
- (C) $\{a^n b^* a^n b^* a^n : n \in \mathbb{N}\}$ is context free.
- (D) If L is context-free and R is regular, then $L - R$ is context-free.
- (E) If L is context-free and R is regular, then $R - L$ is context-free.

PROBLEM 2 (5 points)

Prove that if M is a PDA and there exists a number k such that for all $w \in \mathcal{L}(M)$, the size of the stack is at most k in each step of every possible computation of w on M , then $\mathcal{L}(M)$ is regular.

PROBLEM 3 (Challenge! 3 points)

Write a context-sensitive grammar for the language $\{a^n b^n c^n : n \geq 0\}$.