

CS 3240 : Languages and Computation
Homework V
Due Friday, April 17th 2009, 5 pm
Total Points : 100

Guidelines:

1. You can discuss the homework problems at a higher level with other students. However, you must write the homework solutions completely independently and also report the names of the collaborators with whom you discussed the homework. Do not copy solutions from any other source under any circumstance.
2. Answers should be concise, complete and precise
3. **Return this homework in a box in front of Professor Pande's office KACB 2338**

Question I : Convert the following languages directly (without constructing the CFGs) to non-deterministic pushdown automata (PDA): you must cover all possibilities and include reject state when incoming string does not belong to L [30 points]

- 1 $L = \{a^i b^j c^k, 2i = j \text{ or } j=k\}$
- 2 L consists of strings made out of $\{0, 1\}$ in which the number of 0's and 1's is exactly equal and 0's can 1's can appear in any order. Empty string belongs to L.

Question II: Consider the following grammar: [25 points]

$S \rightarrow aAb \mid bB$
 $A \rightarrow aBb \mid e$
 $B \rightarrow bAa \mid e$
 $D \rightarrow d$

- (a) Devise a non-deterministic PDA for this grammar. You must summarize the PDA in terms of the formal tuple which shows states, initial state, input alphabet, tape alphabet, final states, and transition functions – show a diagram as well.

Question III: Turing machine : [45 points]

- (a) Construct a Turing machine to find the quotient and the remainder obtained after dividing a number X by Y, where X and Y are positive integers. Both integers are represented on the Turing machine tape as 0's separated by #. For example, if X is 7 and Y is 3, we will have 0000000#000~~ on the tape as an input (seven 0's for X and three zeroes for Y). The resulting remainder and quotient will be shown on the tape as xxxxxx0#000#00~~ -- the remainder here is one (shown by one remaining zero as a part of X) and quotient is two (shown by two zeroes). In another example, for X = 9 and Y = 3, it will be xxxxxxxxx#000#000~ which shows a remainder of zero and quotient of three.
- (b) Trace the state transitions and show the output of the TM on a simple input 000#00~~

