

CS 6901 Capstone Exam Systems Fall 2012: Choose any 2 problems.

1) Show the circuit diagram for a 5-bit counter that decrements the stored value on each clock pulse. Use T or JK flip-flops.

2) Consider the following page reference for a virtual memory system in which physical

CS 6901 Capstone Exam Theory Fall 2012: Choose any 2 problems.

1. a. Write a Context Free Grammar (CFG) for the language of nonempty data files – described below.

A nonempty *data file* consists of one or more *records*, where each record is one or more *fields*. Each field is either *integer* (one or more digits) or *string* (one or more alphabetic characters enclosed in double quotes).

Every record (including the last one) ends with a period.

Every field (except the last one in a record) ends with a semicolon.

For simplicity, you may assume that the only digits are {0,1,2} and the only alphabetic characters are {a,b,c,d,e}. That is, $\Sigma = \{ ; , . , 0, 1, 2, a, b, c, d, e \}$

Example data file with 3 records: 0210; "abc"; a.20111; bed; baba; cade;
21. abc .

b. Is your grammar ambiguous? Support your answer.

2. a. Describe carefully the relationships between the languages below using the \subseteq operator. That is, your answer should look like $A \subseteq B \subseteq C$ or $A \subseteq B, A \subseteq C$ etc.

TD = set of Turing Decidable (recursive) decision problems

TA = set of Turing Acceptable (recognizable, recursively enumerable) decision problems

NP = set of decision problems that have nondeterministic polynomial Turing Machines

NPC = set of NP-complete decision problems

P = set of decision problems with polynomial solvers

b. For each problem below, give the most restrictive (smallest) class that it belongs to.

$L_1 = \{ \langle M, w \rangle \mid M \text{ is a Turing machine and } w \text{ is a string and } M \text{ accepts } w \}$

$L_2 = \{ \langle M, w \rangle \mid M \text{ is a Turing machine and } w \text{ is a string and } M \text{ does not accept } w \}$

$L_3 = \{ \langle M \rangle \mid M \text{ is a nondeterministic finite automaton and } L(M) \neq \emptyset \text{ (that is, } M \text{ accepts at least one string)} \}$

$L_4 = \{ \langle G \rangle \mid G \text{ is a context free grammar and } G \text{ is } \textit{ambiguous} \text{ (some string has two parse trees)} \}$

$L_5 = \{ \langle G \rangle \mid G \text{ is a } \textit{connected} \text{ graph (no isolated vertices)} \}$

$L_6 = \{ \langle G, n \rangle \mid G \text{ is a graph with } \textit{Hamiltonian circuit} \text{ (simple circuit } v_1 \text{ back to } v_1 \text{, visits every vertex once)} \}$

$L_7 = \{ N \mid N \text{ is a positive integer and } N \text{ is } \textit{prime} \text{ (no divisors except 1 and } N \text{)} \}$

3. Choose TWO of the theorems below and give their proofs

(i) If L_1 and L_2 are regular languages, then so is $L_1 L_2$

(ii) If L_1 is a context free language, then so is L_1^*

(iii) If L_1 and L_2 are Turing decidable languages, then so is $L_1 \cup L_2$

(iv) If L_1 and L_2 are Turing acceptable languages, then so is $L_1 \cap L_2$