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, = {**;** , **.**., , 0, 1, 2, a, b, c, d, e}

Example data file with 3 records: 0210**; “a**bc **;** 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 operator. That is, your answer should look like A B C or A B, A 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 = { <M, w> | M is a Turing machine and w is a string and M *accepts* w}

L_2 = { <M, w> | M is a Turing machine and w is a string and M *does not accept* w}

L_3 = { <M> | M is a nondeterministic finite automaton and *L(M)* (that is, M accepts at least one string)}

L_4 = { <G> | G is a context free grammar and G is *ambiguous* (some string has two parse trees)}

L_5 = { <G> | G is a *connected* graph (no isolated vertices)}

L_6 = { <G, n> | G is a graph with *Hamiltonian circuit* (simple circuit v_1 back to $v_{1;}$ visits every vertex once)}

L_7 = { N | N is a positive integer and N is *prime* (no divisors except 1 and N)}

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_1L_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 L_2

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