

CS 6901 Capstone Exam Systems Winter 2016: Choose any 2 of the 3 problems.

1) Rewrite  $F(a, b, c, d) = \sum (1, 3, 5, 7, 11, 12, 13, 14, 15)$  in fully simplified product-of-sums form.

2) Consider the semaphore solution to solve the producer/consumer problem with a buffer of  $n$  elements. Write the basic code for producers and consumers. Declare and initialize all semaphores.

3) Consider the following page reference string for a virtual memory system in which physical memory has exactly 3 frames:

5, 1, 2, 1, 5, 8, 1, 6, 8, 5, 6

For each of the following page replacement algorithms, show which references will cause page faults and show the contents of the 3 frames at the time of each fault. Assume that the frames are initially empty. You do not need to show the first 3 faults that are caused by demand paging.

- a) Least Recently Used
- b) Second Chance





Choose any 2 of the 3 problems.

**1. a.** State the Pumping Lemma for Context Free languages.

**b.** Prove that the following language is not context-free:

$$L = \{0^m 1^n 0^p : m = n = p \neq 0\}$$

**2. a.** Define clearly but completely: Language L is decidable.

**b.** Let  $ALL_{DFA} = \{M : M \text{ is a DFA and } L(M) = \Sigma^*\}$  — that is, this is the language of deterministic finite automata that accept all strings. Show that  $ALL_{DFA}$  is decidable.

**3.** If  $G$  is an undirected graph, then a vertex cover of  $G$  is a subset of the nodes where every edge of  $G$  is incident to at least one of those nodes. (An edge and a vertex on that edge are called incident.) The vertex cover problem asks whether a graph contains a vertex cover of a specified size:  $VERTEX-COVER = \{\langle G, k \rangle : G \text{ is an undirected graph that has a } k\text{-node vertex cover}\}$ .

**a.** Give a yes-instance and a no-instance of the vertex cover problem.

**b.** Show that  $VERTEX-COVER$  is NP-complete.

(A list of problems that are known to be NP-complete: SAT, 3-CNF-SAT, CLIQUE, HAMPATH, HAMILTONIAN-CIRCUIT, SUBSET-SUM, 3-Dim-Matching, PARTITION, INDEPENDENT-SET.)