CS 6901 Capstone Exam Systems Spring 2014: Choose any 2 of the 3 problems.

1) Rewrite
$F(a, b, c, d) = a'b'c'd' + a'b'c\,d' + a'b'c\,d + a'b\,c'd' + a'b\,c\,d' + a\,b'c'd' + a\,b'c\,d'$
in fully simplified sum-of-products form.

2) Consider the following two attempted solutions to the 2-process mutual exclusion problem. For each attempt, answer yes/no with a brief justification.
a) Does the code guarantee mutual exclusion?
b) Is it possible that both processes will busy-wait forever? That is, could deadlock occur?
c) Does the code guarantee fairness? That is, is indefinite postponement impossible?
Briefly explain your answers.

Attempt #1: common variables: flag1, flag2 (both initially false)

```
   Process 1
while (true) {
  flag1 = true;
  while (flag2); //empty body
  Critical section;
  flag1 = false;
  Noncritical section;
}
```

```
  Process 2
while (true) {
  while (flag1); //empty body
  flag2 = true;
  Critical section;
  flag2 = false;
  Noncritical section;
}
```

Attempt #2: common variable: lock (initially false)
Assume the existence of an atomic (non-interruptible) test_and_set function that both returns the value of its boolean argument and sets the argument to true.

```
   Process 1
while (true) {
  while (test_and_set(lock));
  Critical section;
  lock = false;
  Noncritical section;
}
```

```
  Process 2
while (true) {
  while (test_and_set(lock));
  Critical section;
  lock = false;
  Noncritical section;
}
```

3) Consider a system with 3 resources (A, B, C) in quantity (7, 7, 6). The Banker's Algorithm is used to allocate resources and it has the following SAFE state:

Available: A B C
1 2 2

Process	Allocation			Max			Need		
	A	B	C	A	B	C	A	B	C
P0	2	1	1	2	4	4	0	3	3
P1	1	1	2	2	4	4	1	3	2
P2	3	2	1	6	6	1	3	4	0
P3	0	1	0	0	3	2	0	2	2

a) Justify why the current state is safe.
b) For each part, write your choices on your solution sheet. You do not need to justify your answers.
i) Select a process and a request of a single instance of an available resource where the request will be denied. The resource must be within the specified need for that process.

Process _____ Resource _____

ii) Select a process and a request of a single instance of an available resource where the request will be allowed.

Process _____ Resource _____

CS 6901 Capstone Exam Data Structures and Algorithms Spring 2014
Choose any 2 problems.

1) Write the function

```
insert_double (*NodeType head, int key)
```

to insert a new integer key into a sorted non-empty doubly linked list beginning at address head. Declare all data structures.

2) Write the function

```
int count2children(treeptr p);
```

that is given a (possibly empty) binary tree and returns the number of nodes in the tree that have both a left child and a right child.

3) Solve the recurrence relation $T(n) = 2T(n/2) + 5$ where $T(1) = 1$ and $n = 2^k$ for a nonnegative integer *k*. Your answer should be a precise function of n in closed form. (An asymptotic answer is not acceptable.) Justify your solution.

Theory Exam Spring 2014

Answer **ANY TWO** of the following three questions:

1. Give the state diagram for a deterministic finite automaton (DFA) that recognizes the following regular language over Σ = {a, b, c}:

   {*w* : *w* contains at least one a, one b, and one c in any order}

2. Prove that the following language over Σ = {a, b, c} is not context-free:

   {*w* : *w* contains the same number of a's and b's and c's in any order}

3. Let $\mathbf{A_{TM}}$ = {*M*, *w* : *M* is a Turing machine that accepts string *w*}
   Let $\mathbf{TWO_{TM}}$ = {*M* : *M* is a Turing machine that accepts exactly two strings}

   Show that $\mathbf{A_{TM} \leq TWO_{TM}}$.