CS 692 Capstone Exam Algorithms Fall 2020: Choose any 2 of the 3 problems.

1) A full node in a binary tree has either no children or exactly 2 children. Given a binary tree, write a function that returns true if all nodes are full nodes. Otherwise return false.
Notes: The function should have just one argument, a pointer to the root.
No global variables may be used.

CS 692: Theory Exam
Fall 2020

Answer any TWO of the three problems listed below. If you attempt all three, only questions one and two will be graded. Please show all work.

Q1. Answer the following questions. In all cases a^\ b}. (10 points each).

a)

9 & ^ * *N 9 (L V D Q X Q G L U H F W H G J U D S K of size Q W D L Q L Q k}.

Prove that Vertex Cover (VC) is in NP.

Please note: You are being asked to prove that VC is in NP. You do NOT need to prove that VC is NP-Complete.

b) How do you prove, in general, that a Problem X is NP-complete? Please give the steps and explain.

1) Virtual Memory – 20pts total

   a. (4pts) Assuming a virtual memory system with FIFO page replacement and an arbitrary page access pattern, will increasing the number of page frames decrease the number of page faults? Why or why not?

   b. (4pts) Assume a 32 bit logical address space and three level paging system. The first 12 bits are for the 1st level page table, the next 8 bits are for the 2nd level page table, the next 6 bits are for the 3rd level page table and remaining 6 are for the offset. How much virtual memory can be accessed?

   c. (4pts) Assume a 32 bit virtual memory system with a page size of 16KB. The Translation Lookaside Buffer (TLB) can hold 512 page table entries . What is the minimum size of the TLB tag?

   d. (4pts) Given a 4 level page table with a Translation Lookaside Buffer (TLB) hit ratio of 92%, What is the effective access time given that a TLB access is 80ns and a memory access time is 160ns?

   e. (4pts) If a machine c

c. (3pts) In a Resource Allocation Graph (RAG), where there is one instance of each resource, a cycle implies that there is deadlock. Is this statement true or false? Explain your answer.

d. (4pts) A system with 5 threads contains 5 instances of resources. Let T be a set of threads and R be a set of resources. R1 has 2 instances. R2 has 1 instance, and R3 has 2 instances

The sets P and R are as follows:

T = {T1, T2, T3, T4, T5}
R = {R1, R2, R3, R4, R5}

.

T1 is assigned an instance of R3 and wants an instance of R1
T2 is assigned an instance of R1
T3 is assigned an instance of R1 and wants an instance of R2
T4 is assigned an instance of R2 and wants an instance of R3
T5 is assigned an instance of R3

Show the set E based on the above assignments and wants.

(6pts) Is there deadlock in this situation? Briefly explain your answer.

3. Mixed (20pts total)

a. (4pts) Explain the difference between a modular kernel design and a monolithic one. What is an advantage of modular design?

b. (3pts) Never requesting a resource after releasing a resource is a valid deadlock prevention scheme. Is this statement true or false? Explain your answer. ioile loopand Explaincoderens f?ants.

c. (4pts) In order to guarantee mutual exclusion, what should the

```
repeat
   flag[ i ] = true;
   turn = J;
   while (  condition   ) do;
         //critical section
         flag[ i ] = false;
         //non critical section
until false;
```

d. Given the code below: Assume the common variable lock is initially false and assuming testSet is an indivisible function that returns the value of its Boolean argument and sets the argument to True.

```
Process A
while (True)
{
   while (testSet(lock));
 // critical section
    lock = false;
    // Non critical section
}
```

```
Process B
while (True)
{
while (testSet(lock));
      // critical section
      lock = false;
      // Non critical section
 }
```

(3pts) Does the code guarantee mutual exclusion? Explain your answer.

(3pts) Is it possible processes will busy wait forever? Explain your answer

(3pts) Is indefinite postponement possible? Explain your answer.