









CS 692 Capstone Exam, Algorithms Fall 2021.

Choose any 2 of the 3 problems. If you attempt all three, only questions one and two will be graded. Please show all work.

Full name: \_\_\_\_\_

Net ID: \_\_\_\_\_

**Question 1)** (20 points) For each function below with input argument  $n$ , determine the asymptotic number of "basic operations" that will be executed. Justify your answer for each case. Note: For the recursive functions, you should first write the corresponding recurrence relation. Then solve the recurrence relation to come up with the asymptotic bound.

$\Theta(1)$   $\Theta(\log n)$   $\Theta(n)$   $\Theta(n \log n)$   $\Theta(2^n)$   $\Theta(n \log n^2)$   $\Theta(n^2)$   $\Theta(n^3)$   $\Theta(n!)$  Other? Please specify.

a)

```
void func(int n) {
    if(n>1)
    {
        func(n-1);
        Perform n basic operations;
    }
}
```

b)

```
void func(int n) {
    if (n > 3)
    {
        func(n/4);
        func(n/4);
        func(n/4);
        func(n/4);
        Perform n basic operations;
    }
}
```

```
void func(int n) {  
    int i=n;  
    while (i>0)  
    {  
        Perform 1 basic operation;  
        i=i/4;  
    }  
}
```

## Question 2)

- a) (8 points) Explain how heap data structures are different from binary search trees (BSTs). Provide at least two main differences and explain each.
- b) (12 points)



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# SYSTEMS EXAM

Fall 2021

90 minutes

Check which problems you are submitting:

#1

#2

#3

How many pages total? \_\_\_\_\_

Please do not write on the back of any pages.

1.

2. (20pts Total) Memory Management ±dynamic partitioning

Given memory partitions of 500K, 300K, 600K (in this order), how would each of the algorithms below place the following processes: 212K, 417K, 112K, 300K, 150K (in this order). Please show your work. Memory can be partitioned

- a) First-fit (4pts)
- b) Best-fit (4pts)
- c) Worst-fit (4pts)
- d) (2pts) Which algorithm makes the most efficient use of memory in this case and why?
- e) (2pts) What is internal fragmentation?
- f) (2pts) What is external fragmentation?
- g) (2pts) What is one disadvantage of both Best and Worst fit?

3. (20 pts Total) Critical Section

Consider the proposed solution of the critical section problem listed below.

Common variables `flag[0] = 0; flag[1] = 0; turn = 0; busy = false;`

```
//Process 1
while ( true )
{
    while (flag2);    //empty body
}

//Process 2
while ( true )
{
    flag2 = true ;
}
```

- b) (5pts) Does the code above guarantee mutual exclusion? If no, give an execution sequence where mutual exclusion is violated. If yes, give an explanation why all three requirements hold.
- c) (5pts) Could deadlock occur? If no, explain why it cannot occur. If yes, give an execution sequence that leads to deadlock.
- d) (5pts) Could bounded waiting occur? If no, explain why it cannot occur. If yes, give an execution sequence that allows bounded waiting.