

CS 692: Data Structures and Algorithms Capstone Exam, Spring 2022.  
Choose any 2 of the 3 problems.

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

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

Question 1 (10 points each)

Consider the following recurrence relations and solve them to come up with a precise function of  $n$  in closed form (that means you should resolve all sigmas, recursive calls of the function). A, etc asymptotic answer is not acceptable here. Justify your solution and show all your work.

- a)  $T(n) = 2T(n/2) + 7n$  where  $T(1) = 1$  and  $J = 2^k$  for a non-negative integer  $k$ .  
For each function  $f(n)$  below, give an asymptotic upper bound using "Big-Oh". Choose from the

following list (the list has no particular order):

- $O(n^3)$ ,  $O(n \log n)$ ,  $O(n)$ ,  $O(2^n)$ ,  $O(1)$ ,  $O(n)$ ,  $O(\log n)$ ,  $O(n \log \log n)$ ,  $O(n^3 \log n)$ ,  
 $O(n^n)$ ,  $O(n!)$ ,  $O(n \log n)$ ,  $O(n^2)$ ,  $O(\log \log \log n)$

You should give the tightest bound possible. You need to justify your answer.

- a)  $f(n) = \log(7^n) + 16$   
b)  $f(n) = 2^n + 10n + 100$   
c)  $f(n) = n^2 + n \log n$

- d)  $f(n) = \begin{cases} 3n + 5, & n < 12 \\ n^2, & n > 12 \end{cases}$   
code for the following operations:  
a) empty\_check

a singly linked list. Declare the data structure