Name: _____ **100 points total**

CS 2123 Homework 4 Fall 2019

Assignment is due at 11:59pm on November 5. Submit a digital copy of the assignment on Harvey as a SINGLE PDF file. The easiest way to scan your work is to use an app on your phone that saves a single PDF (e.g., the Google Drive app for Android phones (see
https://support.google.com/drive/answer/3145835?co=GENIE.Platform%3DAndroid&oco=1) or apps such as Scanner Pro. You can see a list of choices here: https://www.pcmag.com/roundup/349681/the-best-mobile-scanning-apps

NOTE: As a reminder, students who worked in pairs on HW3 must work with a different partner on HW4.

You may submit a lateness coupon request BEFORE the assignment is due by sending an email to cs2123f19@googlegroups.com with Subject "CS2123 Lateness Coupon". All other late work will receive a 10 percentage point deduction per day (including weekends), No late work is accepted beyond five days after the assignment is due.

Q1 (12)	_____
Q2 (24)	_____
Q3 (12)	_____
Q4 (16)	_____
Q5 (16)	_____
Q6 (16)	_____
Q7 (4)	_____
Total (100)	_____

Q1. (12 points)

a. Suppose you are using a Quicksort algorithm that always selects the first value in the list as pivot. Give an example input sequence that takes $\Theta(n^2)$ time to complete.

b. Suppose Quicksort could always pivot on the median of the current sublist. What would Quicksort's performance (expressed in terms of Θ) be in the worst case?

Q2. (24 points)
Use the master theorem to give tight asymptotic bounds for the following recurrences:

a. $T(n) = 2T(\frac{n}{2}) + 7n$

b. $T(n) = 2T(\frac{n}{2}) + n^2$

c. $T(n) = 3T(\frac{n}{2}) + 2n$

d. $T(n) = 7T(\frac{n}{3}) + 4n^2$

Q3. (12 points)
Consider the following recursive function.

```
def myFun(seq):
    if len(seq)<=3: return 3
    le = len(seq)/3
    lo, mid, hi = seq[:le], seq[le:2*le], seq[2*le:]
    plo = myFun(lo)
    pmid = myFun(mid)
    phi = myFun(hi)
    total=plo+pmid+phi
    for x in range(len(seq)):
        for y in range(len(seq)):
            total+=1
    return total
```

a. Write a recurrence relation for `myFun`.

b. Use the master theorem to obtain a tight asymptotic bound for `myFun`.

Q4. (16 points)

Complete the following hash table using closed hashing with **linear probing**, $M = 19$. Follow the sequence of insertions, searches and deletions in the operations table, filling in the sequence of probes and whether the operation succeeded.

Hash Table

Index	Value
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	

Operations

Operation	Probe Sequence	Success? (Y/N)
Insert 7		
Insert 27		
Insert 26		
Insert 46		
Insert 83		
Search 45		
Search 29		
Delete 46		
Insert 64		
Insert 102		
Search 8		

Q5. (16 points)

Complete the following hash table using closed hashing with **quadratic probing**, $M = 19$. Follow the sequence of insertions, searches and deletions in the operations table, filling in the sequence of probes and whether the operation succeeded.

Hash Table

Index	Value
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	

Operations

Operation	Probe Sequence	Success? (Y/N)
Insert 7		
Insert 27		
Insert 26		
Insert 46		
Insert 83		
Search 45		
Search 29		
Delete 46		
Insert 64		
Insert 102		
Search 8		

Q6. (16 points)

Complete the following hash table using closed hashing with **double hashing**, $M = 19$, $R = 11$. Follow the sequence of insertions, searches and deletions in the operations table, filling in the sequence of probes and whether the operation succeeded. Show your work in calculating double hashes below the tables.

Hash Table

Index	Value
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	

Operations

Operation	Probe Sequence	Success? (Y/N)
Insert 7		
Insert 27		
Insert 26		
Insert 46		
Insert 83		
Search 45		
Search 29		
Delete 46		
Insert 64		
Insert 102		
Search 8		

Q7. (4 points) How long (in hours) did you spend on this assignment?