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CS 202 HW 1
SECTION 1

Q1)

$0 \leq 5n^3 + 4n^2 + 10 < cn^4$ *for all* $n > n_0$ so if we choose $c = 5$ and $n_0 = 2$;

$f(n) = 5n^3 + 4n^2 + 10 \leq 5n^4$ for $c = 5$ and $n_0 = 2$ so $f(n)$ is $O(n^4)$.

Q2) Array = [24, 8, 51, 28, 20, 29, 21, 17, 38, 27]

Insertion Sort:

[24, 8, 51, 28, 20, 29, 21, 17, 38, 27] 8 is copied.
[24, 24, 51, 28, 20, 29, 21, 17, 38, 27] shift 24
[8, 24, 51, 28, 20, 29, 21, 17, 38, 27] 8 is inserted. 51 is copied
[8, 24, 51, 28, 20, 29, 21, 17, 38, 27] 28 is copied
[8, 24, 51, 51, 20, 29, 21, 17, 38, 27] shift 51
[8, 24, 28, 51, 20, 29, 21, 17, 38, 27] 28 is inserted , 20 is copied
[8, 24, 24, 28, 51, 29, 21, 17, 38, 27] shift 51,28,24
[8, 20, 24, 28, 51, 29, 21, 17, 38, 27] 20 is inserted , 29 is copied
[8, 20, 24, 28, 51, 51, 21, 17, 38, 27] shift 51
[8, 20, 24, 28, 29, 51, 21, 17, 38, 27] 29 is inserted , 21 is copied
[8, 20, 24, 24, 28, 29, 51, 17, 38, 27] shift 51,29,28,24
[8, 20, 21, 24, 28, 29, 51, 17, 38, 27] 21 is inserted , 17 is copied
[8, 20, 20, 21, 24, 28, 29, 51, 38, 27] shift 51,29,28,24,21,20
[8, 17, 20, 21, 24, 28, 29, 51, 38, 27] 17 is inserted , 38 is copied
[8, 17, 20, 21, 24, 28, 29, 51, 51, 27] shift 51
[8, 17, 20, 21, 24, 28, 29, 38, 51, 27] 38 is inserted , 27 is copied
[8, 17, 20, 21, 24, 28, 28, 29, 38, 51] shift 51,38,29,28
[8, 17, 20, 21, 24, 27, 28, 29, 38, 51] 27 is inserted

Bubble Sort:

[24, 8, 51, 28, 20, 29, 21, 17, 38, 27]
[8, 24, 51, 28, 20, 29, 21, 17, 38, 27] 24 and 8 is swapped
[8, 24, 51, 28, 20, 29, 21, 17, 38, 27] 24 and 51 is not swapped
[8, 24, 28, 51, 20, 29, 21, 17, 38, 27] 28 and 51 is swapped
[8, 24, 28, 20, 51, 29, 21, 17, 38, 27] 20 and 51 is swapped
[8, 24, 28, 20, 29, 51, 21, 17, 38, 27] 29 and 51 is swapped
[8, 24, 28, 20, 29, 21, 51, 17, 38, 27] 21 and 51 is swapped
[8, 24, 28, 20, 29, 21, 17, 51, 38, 27] 17 and 51 is swapped
[8, 24, 28, 20, 29, 21, 17, 38, 51, 27] 38 and 51 is swapped
[8, 24, 28, 20, 29, 21, 17, 38, 27, 51] 27 and 51 is swapped
[8, 24, 28, 20, 29, 21, 17, 38, 27, 51] 8 and 24 is not swapped
[8, 24, 28, 20, 29, 21, 17, 38, 27, 51] 24 and 28 is not swapped
[8, 24, 20, 28, 29, 21, 17, 38, 27, 51] 20 and 28 is swapped
[8, 24, 20, 28, 29, 21, 17, 38, 27, 51] 29 and 28 is not swapped
[8, 24, 20, 28, 21, 29, 17, 38, 27, 51] 21 and 29 is swapped
[8, 24, 20, 28, 21, 17, 29, 38, 27, 51] 17 and 29 is swapped
[8, 24, 20, 28, 21, 17, 29, 38, 27, 51] 29 and 38 is not swapped

[8, 24, 20, 28, 21, 17, 29, 27, 38, 51] 27 and 38 is swapped
[8, 24, 20, 28, 21, 17, 29, 27, 38, 51] 8 and 24 is not swapped
[8, 20, 24, 28, 21, 17, 29, 27, 38, 51] 20 and 24 is swapped
[8, 20, 24, 28, 21, 17, 29, 27, 38, 51] 24 and 28 is not swapped
[8, 20, 24, 21, 28, 17, 29, 27, 38, 51] 21 and 28 is swapped
[8, 20, 24, 21, 17, 28, 29, 27, 38, 51] 17 and 28 is swapped
[8, 20, 24, 21, 17, 28, 29, 27, 38, 51] 28 and 29 is not swapped
[8, 20, 24, 21, 17, 28, 27, 29, 38, 51] 27 and 29 is swapped
[8, 20, 24, 21, 17, 28, 29, 27, 38, 51] 8 and 24 is not swapped
[8, 20, 24, 21, 17, 28, 29, 27, 38, 51] 20 and 24 is not swapped
[8, 20, 21, 24, 17, 28, 29, 27, 38, 51] 21 and 24 is swapped
[8, 20, 21, 17, 24, 28, 29, 27, 38, 51] 17 and 24 is swapped
[8, 20, 21, 17, 24, 28, 29, 27, 38, 51] 24 and 28 is not swapped
[8, 20, 21, 17, 24, 28, 29, 27, 38, 51] 29 and 28 is not swapped
[8, 20, 21, 17, 24, 28, 29, 27, 38, 51] 8 and 20 is not swapped
[8, 20, 21, 17, 24, 28, 29, 27, 38, 51] 20 and 21 is not swapped
[8, 20, 17, 21, 24, 28, 29, 27, 38, 51] 17 and 21 is swapped
[8, 20, 17, 21, 24, 28, 29, 27, 38, 51] 21 and 24 is not swapped
[8, 20, 17, 21, 24, 28, 29, 27, 38, 51] 28 and 24 is not swapped
[8, 20, 17, 21, 24, 28, 29, 27, 38, 51] 8 and 20 is not swapped
[8, 17, 20, 21, 24, 28, 29, 27, 38, 51] 17 and 20 is swapped
[8, 17, 20, 21, 24, 28, 29, 27, 38, 51] 20 and 21 is not swapped
[8, 17, 20, 21, 24, 28, 29, 27, 38, 51] 21 and 24 is not swapped
[8, 17, 20, 21, 24, 28, 29, 27, 38, 51] 8 and 17 is not swapped
[8, 17, 20, 21, 24, 28, 29, 27, 38, 51] 20 and 17 is not swapped
[8, 17, 20, 21, 24, 28, 29, 27, 38, 51] 20 and 21 is not swapped
[8, 17, 20, 21, 24, 28, 29, 27, 38, 51] 8 and 17 is not swapped
[8, 17, 20, 21, 24, 28, 29, 27, 38, 51] 20 and 17 is not swapped
[8, 17, 20, 21, 24, 28, 29, 27, 38, 51] 8 and 17 is not swapped

Q3)

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--------------------------------------------------
Analysis of Selection Sort Using Random Arrays
Array Size              Elapsed Time                    compCount               moveCount
6000                    46.000000                       0               0
10000                   116.000000                      0               0
14000                   227.000000                      0               0
18000                   357.000000                      0               0
22000                   532.000000                      0               0
26000                   746.000000                      0               0
30000                   985.000000                      0               0
--------------------------------------------------
Analysis of Merge Sort Using Random Arrays
Array Size              Elapsed Time                    compCount               moveCount
6000                    0.000000                        0                       0
10000                   0.000000                        0                       0
14000                   0.000000                        0                       0
18000                   0.000000                        0                       0
22000                   0.000000                        0                       0
26000                   8.000000                        0                       0
30000                   10.000000                       0                       0
--------------------------------------------------
Analysis of Quick Sort Using Random Arrays
Array Size              Elapsed Time                    compCount               moveCount
6000                    0.000000                        87055                   143613
10000                   0.000000                        164010                  265367
14000                   0.000000                        233269                  409251
18000                   11.000000                       308746                  449036
22000                   10.000000                       365612                  593436
26000                   3.000000                        442276                  691900
30000                   0.000000                        528867                  910902
--------------------------------------------------
Analysis of Radix Sort Using Random Arrays
Array Size              Elapsed Time
6000                    201.000000
10000                   512.000000
14000                   984.000000
18000                   1607.000000
22000                   2427.000000
26000                   3377.000000
30000                   4461.000000
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--------------------------------------------------
Analysis of Selection Sort Using Ascending Arrays
Array Size              Elapsed Time                    compCount               moveCount
6000                    41.000000                       0               0
10000                   103.000000                      0               0
14000                   194.000000                      0               0
18000                   331.000000                      0               0
22000                   480.000000                      0               0
26000                   676.000000                      0               0
30000                   890.000000                      0               0
--------------------------------------------------
Analysis of Merge Sort Using Ascending Arrays
Array Size              Elapsed Time                    compCount               moveCount
6000                    0.000000                        0                       0
10000                   0.000000                        0                       0
14000                   0.000000                        0                       0
18000                   0.000000                        0                       0
22000                   2.000000                        0                       0
26000                   10.000000                       0                       0
30000                   3.000000                        0                       0
--------------------------------------------------
Analysis of Quick Sort Using Ascending Arrays
Array Size              Elapsed Time                    compCount               moveCount
6000                    31.000000                       17997000                23996
10000                   95.000000                       49995000                39996
14000                   183.000000                      97993000                55996
18000                   305.000000                      161991000               71996
22000                   450.000000                      241989000               87996
26000                   622.000000                      337987000               103996
30000                   845.000000                      449985000               119996
--------------------------------------------------
Analysis of Radix Sort Using Ascending Arrays
Array Size              Elapsed Time
6000                    183.000000
10000                   510.000000
14000                   963.000000
18000                   1608.000000
22000                   2396.000000
26000                   3342.000000
30000                   4445.000000
--------------------------------------------------
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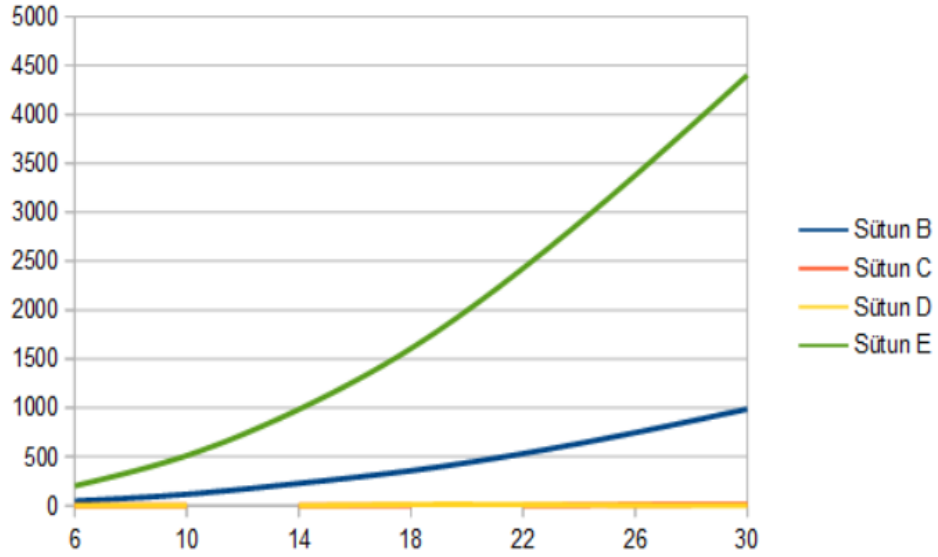
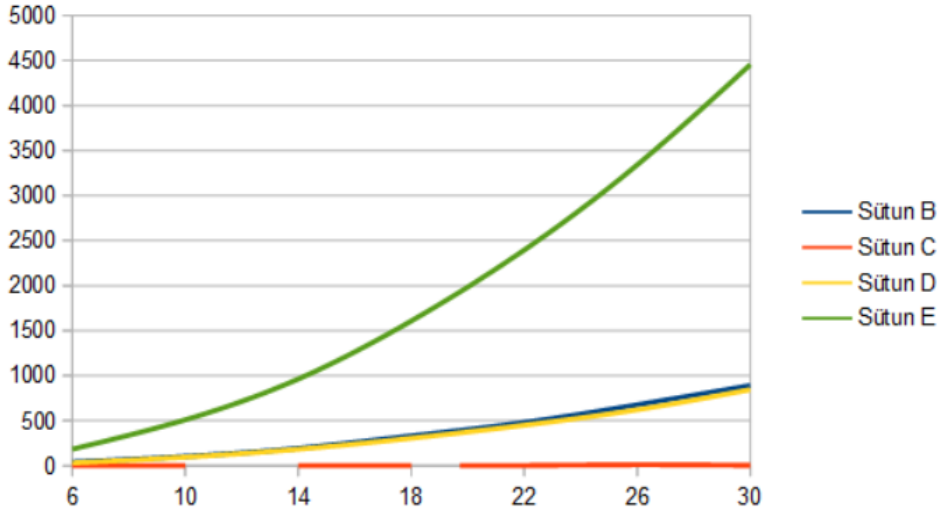
--------------------------------------------------
Analysis of Selection Sort Using Descending Arrays
Array Size              Elapsed Time                    compCount               moveCount
6000                    41.000000                       0               0
10000                   102.000000                      0               0
14000                   204.000000                      0               0
18000                   338.000000                      0               0
22000                   510.000000                      0               0
26000                   707.000000                      0               0
30000                   957.000000                      0               0
--------------------------------------------------
Analysis of Merge Sort Using Descending Arrays
Array Size              Elapsed Time                    compCount               moveCount
6000                    0.000000                        0                       0
10000                   0.000000                        0                       0
14000                   0.000000                        0                       0
18000                   0.000000                        0                       0
22000                   2.000000                        0                       0
26000                   8.000000                        0                       0
30000                   5.000000                        0                       0
--------------------------------------------------
Analysis of Quick Sort Using Descending Arrays
Array Size              Elapsed Time                    compCount               moveCount
6000                    72.000000                       17997000                27023996
10000                   202.000000                      49995000                75039996
14000                   399.000000                      97993000                147055996
18000                   644.000000                      161991000               243071996
22000                   942.000000                      241989000               363087996
26000                   1311.000000                     337987000               507103996
30000                   1764.000000                     449985000               675119996
--------------------------------------------------
Analysis of Radix Sort Using Descending Arrays
Array Size              Elapsed Time
6000                    245.000000
10000                   688.000000
14000                   1351.000000
18000                   2243.000000
22000                   3339.000000
26000                   4704.000000
30000                   6257.000000
```

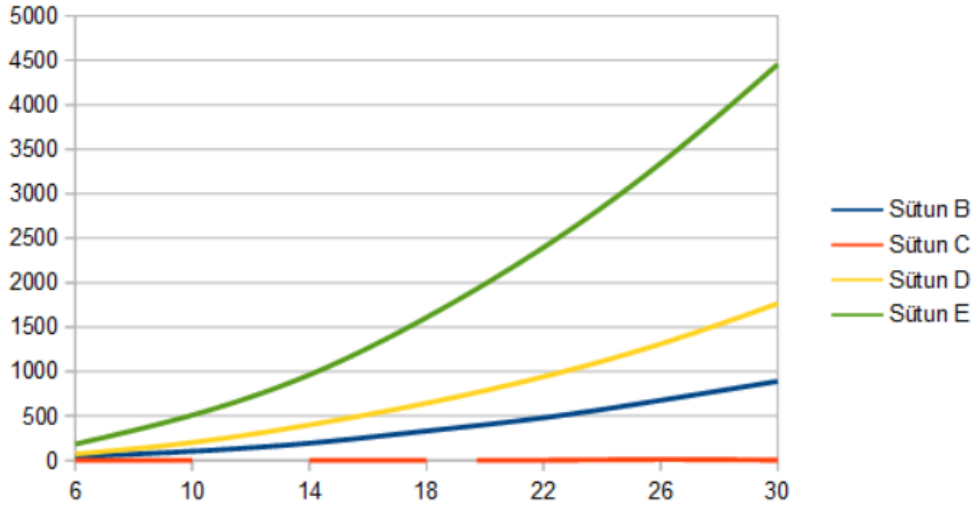
Q4)



GRAPH 1



GRAPH 2



GRAPH 3

A: Selection Sort
B: Merge Sort
C: Quick Sort
D: Radix Sort

x axis : milisecond
y axis: size of array (k)

Graph 1: Random array
Graph 2 : Ascending array
Graph 3: Descending array