Problem 4.

index (mod 3) 1, 2, 3

insertion

a) Pseudo code Not recursive

```
for i = 4 to n do
    if i = 1 (mod 3)
        temp ← A[i]
        j ← i-1  j ← i-3
        while j > 0 and A[j] > temp do begin
            A[j+1] ← A[j]
            j ← j-3
        end while
        A[j+3] ← temp
    end if
end for

for i = 5 to n do
    if i = 2 (mod 3)
        temp ← A[i]
        j ← i-1  j ← i-3
        while j > 0 and A[j] > temp do begin
            A[j+1] ← A[j]
            j ← j-3
        end while
        A[j+3] ← temp
    end if
end for

for i = 6 to n do
    if i = 3 (mod 3)
        temp ← A[i]
        j ← i-1  j ← i-3
        while j > 0 and A[j] > temp do begin
            A[j+1] ← A[j]
            j ← j-3
        end while
        A[j+3] ← temp
```

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```
end if
end for
for i = 7 to n do
    if i = 0 (mod 3)
        temp ← A[i]
        j ← i+1 ; j ← i-1
        while j > 0 and A[j] > temp do begin
            A[j+1] ← A[j]
            j ← j-1
        end while
    end if
end for
```

b) n = 12 Best case comparisons

1 2 3 | 4 5 6 7 | 8 9 10 11 12

1 4 7 10 mod 3 ① → 3 −

2 5 8 11 mod 3 ② → 3 −

3 6 9 12 mod 3 ⓪ → 3 −

9 + 11 = 20

c) n = 12 worst case

$$\sum_{i=2}^{n} \sum_{j=1}^{i-1} 1 = \sum_{i=2}^{n} (i-1)$$

$$= \sum_{i=2}^{n} i - \sum_{i=2}^{n} 1$$

$$= \frac{n(n+1)}{2} - 1$$

10 4 1

10 7 4 1 − 6

11 8 5 2 − 6

12 9 6 3 − 6 + $\left(\frac{12-11}{2}\right)$ = 84 Final Answer

$3 \cdot \left(\frac{4^{1+3}}{2}\right) = 3 \cdot (6) =$ 18 + [illegible] = [illegible]

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d) worst case $n = 3k$ ($k \geq 0$)

$n \quad n-1 \quad n-2 \quad \cdots \quad 2 \quad 1$

$n: \frac{2n}{3} \quad \frac{n}{3} \quad \cdots$

$n-1 \quad \frac{2n}{3}-1 \quad \frac{n}{3}-1$

sort 1 index comparison $2n$

2 index $2n+1$

3 $n+1$

$$1+2+2+\sum_{i=4}^{n/3} 2i + \sum_{i=5}^{n/3} 2i+1 + \sum_{i=6}^{n/3} i+1$$

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