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CE 3345.001

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### Assignment 1

- 1.) Write a recursive method in pseudo code that returns the number of 1's in the binary representation of N. Use the fact that this equal to the number of 1's in the representation of N/2, plus 1, if N is odd.**

```
recBinary(int number)
    calls recBinaryHelper(int number, int sum) ← sum will be 0 when called from
recBinary
    If (number % 2 != 0) ← if number is not divisible by 2
        output/return sum
    else
        increment sum
        recBinaryHelper(n/2,sum)
    end if
```

2.) X

3.) X

4.)

4.) Prove by Induction:  $1^3 + 2^3 + 3^3 + \dots + n^3 = \frac{n^2(n+1)^2}{4}$

Base case:  $S(1) = 1^3 \stackrel{?}{=} \frac{1^2(1+1)^2}{4}$

$$1 \stackrel{?}{=} \frac{(1+1)^2}{4} \Rightarrow 1 \stackrel{?}{=} \frac{2^2}{4} \Rightarrow 1 \stackrel{?}{=} \frac{4}{4} \Rightarrow 1 \stackrel{?}{=} 1 \checkmark$$

Inductive Hypothesis: (Assume  $N=k$ )

$$1^3 + 2^3 + 3^3 + \dots + k^3 = \frac{k^2(k+1)^2}{4}$$

Inductive step: (Prove  $N=k+1$ )

$$1^3 + 2^3 + 3^3 + \dots + k^3 + (k+1)^3$$

$$\downarrow$$

$$\frac{k^2(k+1)^2}{4} + (k+1)^3 = \frac{k^2(k+1)^2 + 4(k+1)^3}{4}$$

$$= \frac{(k+1)^2 [k^2 + 4k + 4]}{4} = \frac{(k+1)^2 (k+2)^2}{4} = \frac{(k+1)^2 ((k+1)+1)^2}{4}$$

$$\uparrow$$

$$\checkmark \quad \frac{k^2(k+1)^2}{4}$$

5.) Suppose your calculator only did base 10 logarithms, write an expression to compute log base 2 of 64 using log base 10.

Using change of base formula:  $\log_a(x) = \frac{\log_d(x)}{\log_d(a)} \therefore \log_2(64) = \frac{\log_{10}(64)}{\log_{10}(2)}$

- 6.) An integer subarray is called alternating if any two consecutive numbers in it have opposite signs (i.e. one of them should be negative, whereas the other should be positive).

Given an array of n integers, write a pseudocode to compute for each index i, the length of the longest alternating subarray starting at i.

```
x equals index i
Boolean flag equals false
while x < array length, do
    if at first element of the subarray (e.g counter equals index i)
        if first element is positive
            flag equals true
        else
            flag equals false
        end if
    else
        if current element is positive and flag is positive
            exit loop
        else if current element is negative and flag is negative
            exit loop
        else
            increment counter
            if current element is positive
                flag = true
            else
                flag = false
            end if
        end if
    end if
    increment x
end loop

output counter/display results
```