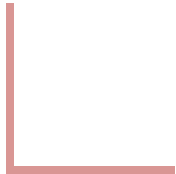# Mathematical Foundations for Computer Applications

Mathematical Induction- Problems

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3. Show that $3^n - 1$ is a multiple of 2 , using Mathematical Induction

1. Show it is true for **n=1**

$$3^1 - 1 = 3 - 1 = 2$$

Yes 2 is a multiple of 2. $3^1 - 1$ is true
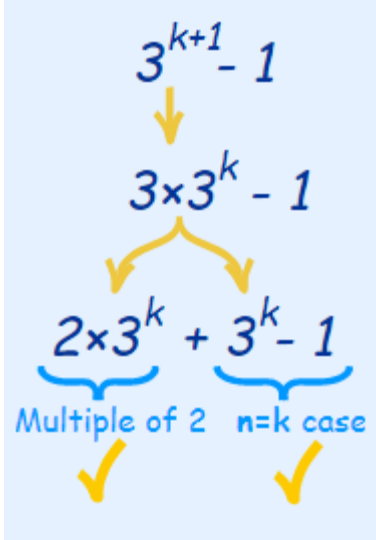
2. Assume it is true for **n=k**

$3^k - 1$ is true

Now, prove that $3^{k+1} - 1$ is a multiple of 2

$$3^{k+1} - 1$$

$$\downarrow$$

$$3 \times 3^k - 1$$

$$\swarrow \qquad \searrow$$

$$\underbrace{2 \times 3^k}_{\text{Multiple of 2}} + \underbrace{3^k - 1}_{\text{n=k case}}$$

✓ ✓

So, $3^{k+1} - 1$ is true

4. Prove by Mathematical Induction

$$\frac{1}{1.2} + \frac{1}{2.3} + \frac{1}{3.4} + \cdots + \frac{1}{n(n+1)} = \frac{n}{n+1}$$

Where 'n' is positive integer.

Basic Step: Let n=1 $\frac{1}{1.2} =$

$\frac{1}{1+1}$

$$\frac{1}{2} = \frac{1}{2}$$

Induction step: Assume that the given statement is true for n=k

i.e $\dfrac{1}{1.2} + \dfrac{1}{2.3} + \dfrac{1}{3.4} + \text{----------} \quad \dfrac{1}{k\,(k+1)} = \dfrac{k}{(k+1)} \longrightarrow 1$

To prove

$$\dfrac{1}{1.2} + \dfrac{1}{2.3} + \dfrac{1}{3.4} + \text{----------} + \dfrac{1}{k\,(k+1)} + \dfrac{1}{(k+1)(k+2)} = \dfrac{k+1}{k+2} \longrightarrow 2$$

Substitute eqn 1 in eqn 2 we get

$$\text{LHS} = \dfrac{k}{(k+1)} + \dfrac{1}{(k+1)(k+2)} = \dfrac{k(k+2)+1}{(k+1)(k+2)} = \dfrac{k^2+2k+1}{(k+1)(k+2)} =$$

$$\dfrac{(k+1)(k+1)}{(k+1)(k+2)} = \dfrac{(k+1)}{(k+2)} = \text{RHS}$$

By the principle of mathematical induction the given statement is true for all n>=1

1. Prove that
$\Sigma n^2 = 1^2 + 2^2 + 3^2 + \ldots + n^2 = [n(n+1)(2n+1)] / 6$ Using Mathematical Induction

2. Using Mathematical Induction Prove that $n! > 2n$ Where 'n' is a positive integer greater than or equal to 4.

3. Show that $n^3 + 2n$ is divisible by 3 using Mathematical Induction

THANK YOU

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