

# Experiment-3

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## Mathematical derivation:

**Goal:** Finding the value of the division  $N/D$ .

### **Newton Raphson method:**

Here for finding the value of  $N/D$  first I will find the value of  $1/D$  then multiply it with the value  $N$ .

#### **Finding 1/D:**

Consider a function  $f(x) = 1/x - D \Rightarrow f'(x) = -1/x^2$

Newton iteration is :

$$x_{k+1} = x_k - \frac{f(x_k)}{f'(x_k)}$$

$$x_{k+1} = x_k(2 - D \cdot x_k)$$

Now here I assume an initial value  $x_0$  then go on calculating the values of  $x$  until reaching a point such that  $x_{k+1} \approx x_k$  then consider that value of  $x_k$  as  $1/D$

And multiple  $x_k$  with the number  $N$  to get the value of  $N/D$ .

#### **For 15/23:**

Here  $N = 15, D = 23$ ;

Here I am considering the nearest 5 multiple of the number  $D$  as my first assumption value.

So the nearest 5 multiple of  $23 = 25$ .

So  $x_0 = 1/25 = 0.04$

$$x_1 = x_0(2 - (D)(x_0)) = (0.04)(2 - (23)(0.04)) = 0.0432$$

$$x_2 = x_1(2 - (D)(x_1)) = (0.0432)(2 - (23)(0.0432)) = 0.04347648$$

$$x_3 = x_2(2 - (D)(x_2)) = (0.04347648)(2 - (23)(0.04347648)) = 0.0434782607$$

$$x_4 = x_3(2 - (D)(x_3)) = (0.0434782607)(2 - (23)(0.0434782607)) = 0.043478260869$$

$$\Rightarrow 15/23 = 15 \times x_4 = 15 \times 0.043478260869 = 0.6521739130435$$

**The matlab code outputs for different divisions are:**

$$15/23 = 0.65217391304347838155$$

$$23/15 = 1.5333333333333321491$$

$$11/19 = 0.57894736839843763399$$

$$13/29 = 0.44827586206828229365$$

$$7/3 = 2.3333333333290271483$$

$$19/17 = 1.11764705882351811361$$

**The verilog code outputs for different divisions are:**

$$15/23 = 0.65217391304347838000$$

$$23/15 = 1.5333333333333320000$$

$$11/19 = 0.57894736839843763000$$

$$13/29 = 0.44827586206828229000$$

$$7/3 = 2.3333333333290270000$$

$$19/17 = 1.11764705882351810000$$

As seen above, there is a slight difference between the Verilog and MATLAB results, on the order of  $10^{-17}$ . This difference is extremely small and can generally be neglected.

The bar plot below illustrates the differences between the MATLAB and Verilog results, scaled by  $10^{17}$ , for the various divisions.

