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Solution of Repeating Non-Terminating Problem in Division

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Abstract: This article discusses the drawbacks of decimal theory in terms of repeating and non-terminating problems that may not give complete real results. This problem of decimal theory has persisted from its discovery to the present day. For this problem a theory has been developed in this research which proves to be better for repeating and never ending problem which is called L-Sign theory. The data which does not give hundred present absolute real result by decimal division method like 10/3, 5/11, 22/7[approximation of π(Pi)] and many more like these can be divided by this new L-Sign method to get absolute real result, the result obtained will be absolute real value of the given data. Mathematical operations can be easily performed with other numbers of the obtained results. Apart from this, the reality of these results has been checked by different methods.
Keywords: Decimal division method, End of Remainder, Repeating Non Terminating Problem

I. INTRODUCTION

In the history of mathematics, the discovery of decimal theory has facilitated our access to the smallest scale of numbers and we have been able to study any number or quantity law to the smallest level.

For example, if we want to find the value of the fourth or 100th part of 10, then 10/4 = 2.5 or 10/100 = 0.1 can be easily calculated by dividing 4 in 10 by the decimal division method, but in the same decimal Inconsistencies or deficiencies in theory have persisted from its discovery to the present day.

For example, if we see, the decimal division method cannot fully explain the third part of 10 i.e. 10/3, the 11th part of 5 i.e. 5/11 and we get results like 3.333333 ... and 0.4545454545 ...... respectively. There can be innumerable number of figures whose division by decimal division method shows repetition of one or more numbers after the decimal like 3 is repeating in 3.3333 and 45 in 0.454545. After 1, 2 or more places, we carry forward our calculations by taking the value of the numbers, but this value can be close to the absolute and real value but cannot be completely real value. These problems are being solved through this L- Sign theorem. Examples of these problem

Meter/feet- If we have to convert 1 meter into feet in practice, then we cannot get completely accurate values from the decimal system.

1 meter = 100 cm

1 feet= 30 cm

$$= \frac{100}{30} = 3.3333\ldots..$$

The result obtained by this method is not completely accurate because after 3.___ in the result we take 1, 2 or more places and multiply back by 30 then the result will be 99.99999.... cm but in practice we took 100 cm.

22/7 -[approximation of π (Pi)] Circumference/Diameter of Circle

Although pi is an irrational number, in practice 22/7 calculated as pi. Found that this practical value also calculated by decimal division method, then the following results will be obtained-

$$\frac{22}{7} = 3.142857142857142857\ldots\ldots$$

In this 142857 is repeated after decimal and remainder also obtained so 3.142857.... Also not a complete real value of 22/7.

When prime number as divisor

$$\frac{32}{19} = 1.684210526315789473\ldots.$$

$$\frac{32}{11} = 2.909090\overline{9}0\ldots\ldots$$

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Here 11 and 19 is a prime number so that on dividing 32 a series of numbers are repeating after the decimal in the first case while 90 is repeating after the decimal in the second case so it is clear that the appropriate result is given data has no real value.

Also ,

$$\frac{10}{9} = 1.11111.\ldots\ldots$$

$$\frac{50}{52} = 0.96153846153\ldots\ldots$$

$$\frac{8}{7} = 1.142857142857\ldots\ldots$$

There can be an infinite number of figures whose exact value cannot be obtained by the decimal division method.

II. L-SIGN THEOREM TO SOLVE THIS PROBLEM

Such figures, when divided by the decimal division method, there is repetition of one or more numbers after the decimal in the quotient and in which continuous remainder is obtained, During division, starting from multiplying by 10 at the level of the primary remainder (i.e. dividing into parts of 10 times lower value) the remainder is multiplied in ascending order by 11 12 13 14... (i.e. step to step dividing into part of lower values) it must necessarily result in one level of remainder multiplied by a number which is equal to the divisor, some of its factor, its multiple or a factor of its multiple.

Then the obtained number will be completely divided by the divisor and the obtained quotient will be the complete real value of the given figure and the value of the remainder = 0 (zero) and these numbers will not be repeated in the quotient. Therefore, the value of the quotient obtained in this way will be 100% absolute real value.

Experiment of L–Sign Theorem

Example 1 $\frac{10}{3}$

Decimal division method

```
3)10(3.333...
 - 9
   10
  - 9
    10
   - 9
     1
```

L-Sign Method

```
3 )10(3|338
  - 9
   1X10=10        — Here the primary remainder 1 divided by
     - 9            10 times the lower value
      1X11=11     — Here the remainder 1 is divided by 11
        - 9         times the lower value
         2X12=24    Here the remainder 2 is divided 12 times
           -24      into the lower value
            xx
```

Explanation

1) In the above example, we see that on dividing 10/3 by the decimal division method, 3 is repeated after the decimal point in the quotient and the remainder 1 is also repeating. On the other hand, dividing 10/3 by L-Sign method, we see that the remainder 1 is obtained in the first level, it is multiplied by 10, in the next level by 11, then in the next level the remainder 2 is multiplied by 12. Which is a multiple of divisor 3, so finally 24 is obtained which is completely divisible by 3 to 8 times and the remainder is zero and the value of quotient is 3∟338.
2) Here we see that the base of every 3 in the first quotient ie 3.333... Is 10. But in the quotient obtained from L-Sign 3∟338, after the (∟) sign, base of the first 3 is 10, the base of the second 3 is 11, and the base of 8 is 12.

Verification of Accuracy

Using L-Sign, the value of 10/3 will be 3∟338. Now to check the correctness of this result, in case of multiplying 3∟338 back by 3 and getting the product 10 again, the correctness of the L-Sign Division method will be confirmed.

```
 3L338 X 3      3X 8 will give 24 but being base 12, there will be a
    20           0 in the place and the 2 will be carried
 +   9x         - In the next step, 3X3 = 9 and the place being
    9x           11 base, only 9 will come in the unit place
 + 9x
 + 11           - carry
  10.000        - Here it will be 9 + 10 = 11 but due to the base being
                 11, 0 at the units place, and there will be 1 carry
```

So doing 3∟338 × 3 again we get 10 so L-Sign division operation is correct.

Example 2 Approximation of Pi (π) = 22/7

Decimal Method (Division)

```
7 ) 22 ( 3.142857.....
   - 21
      10
    -  7
       30
      -28
        20
       -14
         60
        -56
          40
        - 35
           50
          -49
            1
```

We see that 1 will be obtained 1 as the first remainder, then again after the division of 6 steps, again 1 is obtained as the remainder. So it is clear that in this method 142857 will keep repeating after the decimal in the quotient and 22 will never be completely divided by 7.

L-Sign division method

```
7 ) 22 ( 3∟14876
   -21
    1x10=10
       -7
        3x11=33
           -28
            5x12=60
               -56
                4x13=52
                   -49
                    3x14=42
                        -42
                         xx
```

According to this method, the remainder 1 obtained in the first step is multiplied by 10, that is, 10 times divided into the lower value. By multiplying the retrieved remainder by 11, 12, 13, and 14 step by step respectively according to the rule, the final remainder 3 obtained multiplying by 14 which is a multiple of 7. In this way the final result is 42 which is completely divided by 7 to 6 times leaving remainder zero and quotient 3∟14876 which is the exact real value of 22/7.

III. VERIFICATION OF ACCURACY

To confirm the correctness of the above figure, multiply the quotient 3.14876 by 7, if the result is 22, then the correctness of the process is confirmed.

```
3|14876 X 7
       30        — a
     3 10x       — b
    4 8 xx       — c
   2 6x xx       — d
    7xx xx       — e
  21 xxx xx      — f
  ---------
  22.000 00      — g
```

1) 7× 6 = 42 but here being base 14, 42/14 = 3, zero at ones place and carry 3 unit to next place
2) Here 7× 7 = 49 but being base 13, 10 at ones place, and 3 will be carry.(49= 3×3 +10)
3) Here 8×7 = 56 but due to base 12, 8 will come at the ones place, and there will be 4 carries.(56= 4×12 + 8)
4) Here 7×4= 28 but being base 11, 6 at ones place, and 2 will be carry.(28= 2×11 +6)
5) Here 7 × 1 = 7, because the base of the number is 10, the behavior of the action will be like a decimal system and 7 will come at the ones place.
6) Here 7 × 3 = 21, which is the term before the decimal, so it will behave like a decimal method.
7) The same rules will be followed while summing the results obtained from multiplication, that is, according to the base place of the number, the behavior of summation will be done.

We see that the result 3∟14876 obtained from 22/7 multiplied by 7 is gives 22 so the appropriate division operation is correct.

Example 3 Feet/Meter

Absolute accuracy can be obtained by converting meters to feet by L-Sign division method

1 Meter = 100cm

1 feet = 30 cm

```
30 ) 100 ( 3|338
   - 90
    10x10=100
       - 90
        10x11=110
            - 90
             20x12=240
                 - 240
                   xxx
```

Here we see that the result is 3∟338 i.e. converting 1 meter to feet will give 3∟338 feet. Because in this number, after the L-Sign (L), the base of the numbers is in increasing order according to the rules, so it can be called the L-Sign feet. And all the units and results obtained by this method can be addressed by adding the word L-Sign and such numbers can be addressed by L-Sign number.

Example 4

a) 32/19= 1.684210526315789473….

→The value obtained by decimal method is here a long number series which repeats.

$\frac{32}{19} = 1\llcorner 69320\overline{11}0\overline{14}5\overline{13}$ (L-Sign method)

As given it is the value obtained from the L-Sign of 32/19 which is the exact real result of the figure. Due to the increasing order of base of numbers after the (L) sign. In such obtained result or L-Sign number, in ones place or position of number can be of 1, 2 or more digits, it will be displayed by putting a bar symbol above the number. As shown in the above result as $\overline{11}$, $\overline{14}$, $\overline{13}$.

b) 32/11= 2.90909090………. (Decimal division method)

= 2.91 (L-Sign division method)

c) 10/9 = 1.1111………(Decimal division method)

= 1.112895 (L-Sign division method)

d) 8/7 = 1.142857142857…….(Decimal division method)
= 1.14876 (L-Sign division method)

e) 50/52 = 0.96153846153846……. (Decimal division method)
= 0.9693 (L-Sign division method)

It is known from the above examples that one or more numbers are repeating in the value obtained by decimal division method and the obtained value is close to the actual value but not 100% accurate. On the other hand, the result obtained by the L-Sign method is the absolute actual value or result of the given data.

IV. ADDITION, SUBTRACTION, MULTIPLICATION DIVISION

A. Addition

Process executed from two examples 10/3 and 5/7

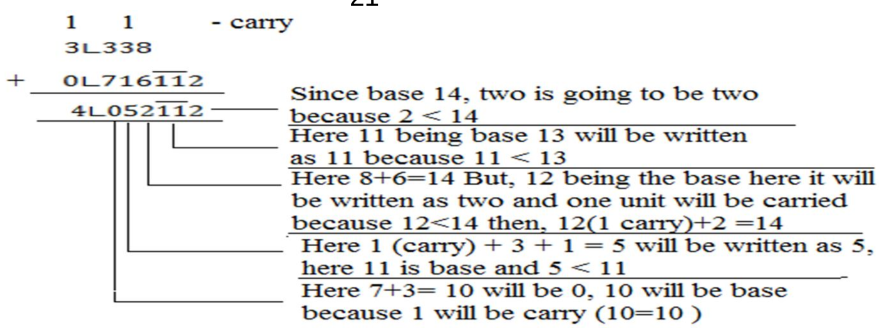
$$\frac{10}{3} + \frac{5}{7} = \frac{85}{21}$$

Where

$$\frac{10}{3} = 3L338$$

$$\frac{5}{7} = 0L716\overline{11}2$$

$$\frac{85}{21} = 4L052\overline{11}2$$



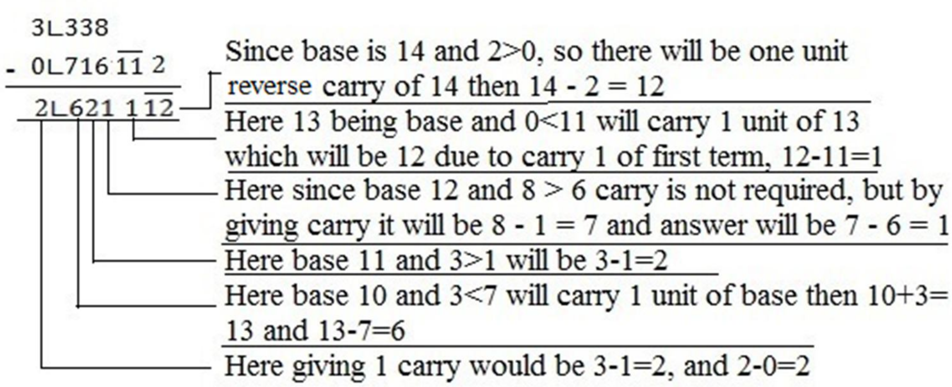
B. Subtraction

$$\frac{10}{3} - \frac{5}{7} = \frac{55}{21}$$

$$\frac{10}{3} = 3L338$$

$$\frac{5}{7} = 0L716\overline{11}2$$

$$\frac{55}{21} = 2L6211\overline{12}$$



The result obtained from the above difference process is $2\llcorner 6211\overline{12}$, and the result obtained from the division of 55/21 being equal proves that the process is correct.

C. Division

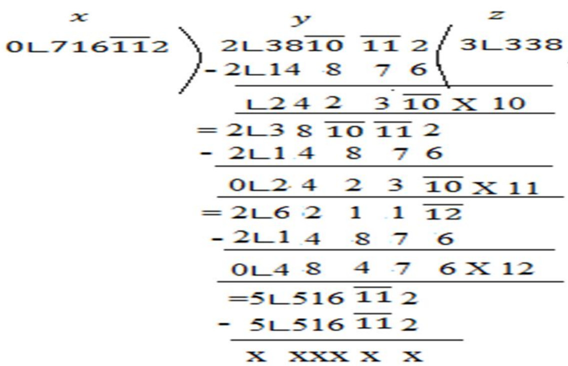
$$z = \frac{10}{3} = 3\llcorner 338$$

$$x = \frac{5}{7} = 0\llcorner 716\overline{11}2$$

$$y = \frac{50}{21} = 2\llcorner 38\overline{10}\ \overline{11}\,2$$

$$\frac{10}{3} \times \frac{5}{7} = \frac{50}{21}$$

Now the product of both the numbers, 50/21 will be divided into 5/7, and the quotient obtained from the L-Sign of the appropriate figures will be checked by the L-Sign process.



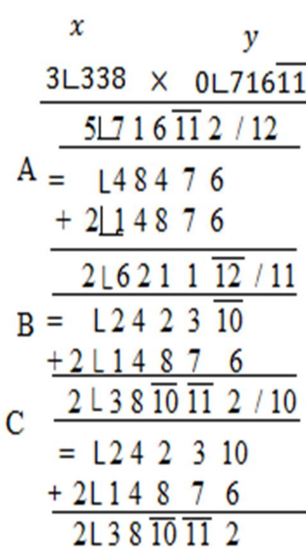
D. Multiplication

$$x = \frac{10}{3} = 3\llcorner 338$$

$$y = \frac{5}{7} = 0\llcorner 716\overline{11}2$$

$$\frac{50}{21} = 2\llcorner 38\overline{10}\ \overline{11}\,2$$

$$\frac{10}{3} \times \frac{5}{7} = \frac{50}{21}$$



Explanation Multiplexing

Here x =10/3=3∟338 has three numbers after the L-Sign sign i.e. sequence of numbers up to base 12, same y=5/7 = 0∟716$\overline{11}$2 has sequence of numbers up to base 14, so by minimization procedure Let us multiply unit number of x i.e. 8 by the value of y.

1) Multiplying 8 by y gives 8 × 2 = 16 i.e. 16 >14 because base of 2 is 14. So 2 of 16 and one unit of 14 will be carried, again 8 × 11 = 88 and 88 + 1(carry) = 89, because the base of 11 is 13. So 78+11=89 , 13 will be 6 unit carry and 89 will be 11 Similarly, following the L-Sign method, we get 8×y = 5∟716$\overline{11}$2 Since the base number of 8 is 12, we will divide the result by 12, that is, 5∟716$\overline{11}$2 /12 = ∟45476.
2) In the next step 3×y will do according to the appropriate rules, And will sum the obtained result with ∟48476, now again divide the obtained result by 11 (because the number 3 is the base 11 number of X) result will be ∟2423$\overline{10}$.
3) After this again 3× Y will be done and the result will be added to ∟2423$\overline{10}$ according to the rules. Divide the result obtained from the sum by 10 because 3 is the number of base 10 of the number X.
4) Now the result will be ∟2423$\overline{10}$, the last 3 from X will be multiplied by Y, the result obtained will be added to ∟2423$\overline{10}$ according to the rule, in this way X×Y = 2∟38$\overline{10}$ $\overline{11}$2. And on dividing 50 / 21 by L-Sign method, the same i.e. 2∟38$\overline{10}$ $\overline{11}$2 is obtained, so the above procedure is correct.

V. RULE FOR MULTIPLYING L-SIGN RESULTS

When for multiplication both the sides have the same terms after the (L) L-Sign.

$(3∟338)^2$ =

x y
3∟338 × 3∟338
A 26∟674 /12
= 2∟22543$\overline{10}$
\+ 10∟000
B 12∟22544$\overline{10}$ /11
= 1∟112895
\+ 10∟000
C 11∟112895 /10
1∟112895
\+ 10∟000
11∟112895

Or $(10/3)^2$ = 11∟112895

In the above example, it can be seen that due to both being the same number and in both there are 3 terms after the l sign, that is, numbers up to 12 base order.

So here in the first term, multiply the first number on the right side of X by 8 and the first number on the right side of the left side by 8. Or 8×8=64, since it is a 12 base order number, therefore 64 will be carried as 4 and 12 as 5 units (60).

In the next step multiply 8 in X term by 3 in Y term 83 = 24 + 5 carry = 29. Since the base number of 3 in this term is 11, so 29 will be written as 7. And 2 units of 11 (11× 2 = 22) will be carry.

Here, following the same base order, we will multiply 8 by the whole y term (following the base order of the numbers of the y term). Now the result is 26∟674.

Since X term has 8 whose base order is 12, so the result obtained will be divided by 12. Now the result obtained will be added to the result obtained after multiplying the second number of X term i.e. 3 by Y-term.

Now the result (B) obtained from this sum will be divided by 11, because the base number of the number 3 in the x term is 11.

Similarly, following the rules of base order, the next number of x will be multiplied by y-term again.

By addig the obtained result to the complete result, the result(C) obtained will be divided by 10, in this way, following the same rules, we will get the final result.

Multiplying a whole number with the L-Sign result

x y
3∟338 × 353
10∟000 10∟000 X 1
166∟674 166∟674 X 10
1000∟000 1000∟000 X 100
1176∟674

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We see that the term x is L-Sign result and y is a whole number. The first number to the right of the y term is multiplied by 3 with the whole x term, then 10 ∟000 is obtained, again if we multiply 5 of the y term by the x term, then 16∟674 is obtained. Because 5 is a number in the tens place, so multiplying it by 10 will give 16∟674× 10 = 166∟674. After this 3 of y term will be multiplied with x term, now the result 10∟000 will be multiplied by 100 because "3" is the number of hundreds place 10∟000 ×100 =1000∟000 will be obtained. So if we add all the results then finally we will get X× Y = 1176∟647

Multiplication of L-Sign number/result with a decimal number.

x		y
3∟338	×	33.55
∟174		-16∟674/ 100
+ 1∟674		-16∟674/ 10
+ 10∟000		-10∟000×1
+ 100∟000		-10∟000×10
111∟838		

In the above example, first the number 5 which is after the decimal (hundredth base) from the right side of y will be multiplied by the X term following the base order rules of the L-Sign, and divide the result by 100. Again multiply the second 5 from the right side by the X term, now divide the result by 10 because the base number of 5 is 10. Then multiply 3 by the X term. Since 3 is the unit base number, we will multiply the result by 1. Again multiply the remaining 3 by X term and multiply the result by 10 as it is a base ten number. The sum of all the results thus obtained will be x ×y = 111∟838

The "0" rule for division involving L-Sign numbers.

1) When both divisor and dividend are L-Sign numbers or resultant then-

$$\frac{10}{3} = 3∟338$$

$$x \quad \frac{5}{7} = 0∟716\overline{11}2$$

$$y \quad \frac{50}{21} = 2∟38\overline{10}\ \overline{11}\,2$$

Here x will be taken as divisor and y as dividend.

x | y | z

0∟716 $\overline{11}$ 2) 2∟38 $\overline{10}$ $\overline{11}$ 2 (3∟338

A - 2∟14 8 7 6

∟24 2 3 $\overline{10}$ × 10

B = 2∟38 $\overline{10}$ $\overline{11}$ 2

-2∟14 8 7 6

0∟ 24 2 3 $\overline{10}$ × 11

C = 2∟62 1 1 $\overline{12}$

- 2∟14 8 7 6

0∟48 4 7 6 × 12

= 5∟71 6 $\overline{11}$ 2

- 5∟71 6 $\overline{11}$ 2

x xx x x x

Explanation- In the division it is seen that the divisor x which is the value of the L-Sign number 5/7 is divided by the divisor y = 2∟3$\overline{10}$ $\overline{11}$2

In step A, we see that after taking the value of x 3 times, the result obtained is subtracted from y following the rules of L-Sign subtraction. Then the result ∟2423$\overline{10}$ (as the divisor is less than x) is multiplied by 10 following the L-Sign division method, i.e. divided by 10 times the lower value of the number.

In step B, by taking the value of x 3 times (multiplication) and subtracting it from the above result, the obtained result is again multiplied by 11 according to the L-Sign division method. Now in Step C after division process the result obtained is multiplied by 12. In the obtained result, x was divided 8 times, thus the value of the remainder is 0 and the quotient is 3∟338, so the above process is correct.

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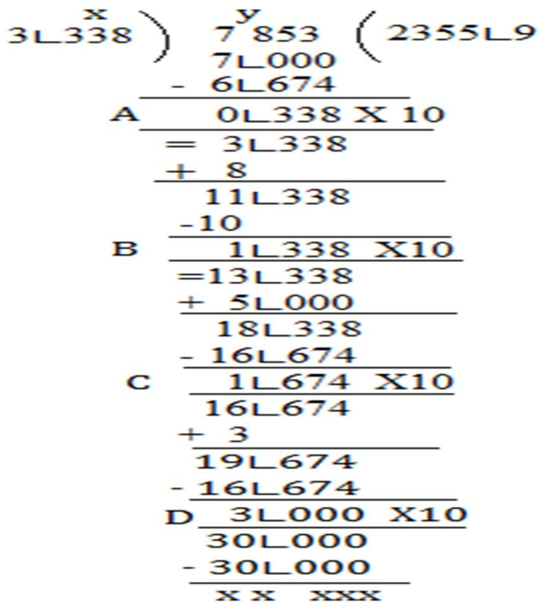
2) When the divisor is L-Sign number and the dividend is a whole number.

Here X will be taken as divisor= 3∟338 and Y as dividend=7853.

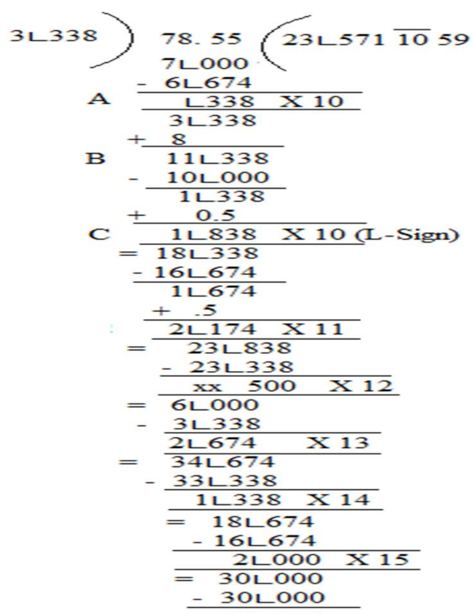


In the above division it is seen that y = 7853 is a four digit whole number. X = 3∟338, X < 7. So first we will divide by 7, which divide twice. Subtract the result from 7 (following the L-Sign base order rule). Now the result A is obtained which will be multiplied by 10. We will add 8 to the second number of Y term in the result obtained from multiplication. Now we will divide the obtained result by X, again the result will be B= 1∟338. Now multiply B by 10 again, and keep repeating the same process. Then the final result will be D= 3 multiplying it by 10 will give 30. Which will be completely divisible by X in 9 times, thus the quotient will be 2353∟9.

Dividing a decimal number By an L-Sign number-

X (divisor) = 3∟338

Y (dividend) =78.55



In the above example, let us see that the dividend y is a two digit number after the decimal point. We have to divide this by x333 8 which is a L-Sign number. First divide x by taking 7 from y. Now multiply the obtained result A by 10. 8 will be added to the obtained result, then 11 338 (B) will be obtained. If we divide B by X and add 0.5 to the result obtained, then the result will be C. It is observed that c < x, hence from here following the increasing basis in the L-Sign rule multiply the obtained results by 10, 11, 12, 13, 14, 15 respectively and the remainder obtained from x in 9 times gets divided. And the value of the remainder becomes 0, so the number is divided completely and in this way it can be processed by the above method.

VI. CONCLUSION

In this paper, an L-Sign method has been developed to solve repeating and non-terminating problems and reach its absolute real value, which proves to be an important discovery in the history of mathematics after the failure of the decimal division method. Through this L-Sign method, we can easily solve such problems which could not reach their real value like π and which were impossible to bring hundred percent real value in mathematical operations.

In this paper compatibility of L-Sign numbers with normal numbers has also been proved by addition, subtraction, multiplication and division.

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