RECURRING DECIMALS FOR DENOMINATOR WITH N-DIGITS

Kailash, S. K. Shrivastava and P. Mishra

Physics Department, B.N.V.P.G. College, Rath, Hamirpur, U.P., 210431, India

Abstract

The scientists and technocrats are paying their keen interest in studying the Vedas which are eternal source of all knowledge and wisdom. Vedic Mathematics is a boon for whole mankind which may be exhausted for scientific and technical purposes. In present work, the recurring decimals are evaluated for denominators containing any number of digits 0 with 1 at unit place like 2001, 30001... and digit 9s like 1999, 39999... for all possible numerators in decimal system. The Sutras "Ekadhikena Purvena (One greater than the previous one)" and "Ekanyunena Purvena (One less than the previous one)" and Upsutra "Anurupyena (By Ratio)" are used extensively for this study. Various methods for evaluation of recurring decimals are widely discussed. Some suitable programs are written and executed for these evaluations. These programs can be utilized for other fractions (denominator containing n-digits). The results thus obtained are discussed and concluded.

Key Words: Vedic Mathematics, Recurring Decimal, n-digits Denominator

INTRODUCTION

A lot of attention has been paid for computer education and training at Government and private level for students, teachers, research scholars, Scientists, academicians industrialists, administrators and technocrats. The computer training and education has brought multiple revolutions in every sphere and dimension of modern life. Not only this, its implications in space research been proved as boon for mankind throughout the world. Computer has succeeded in uniting whole globe into single net bringing new geopolitical transformations through television and other telecommunication systems. Any critical and microscopic innovation in computer software and hardware will certainly derive something which till now was not discovered. The new derivatives in computer software and hardware will accelerate computer operations saving time and simplifying mathematical complications. Any such discovery will enhance welfare of whole mankind. It is by virtue of these insights and creative thinking the authors have proposed a method of evaluation of recurring decimals in decimal number system. This method will synthesize different schools of mathematical knowledge bringing evolution in computer science opening new horizon of computer education and its applications. The scientists and technocrats are paying their keen interest in studying the Vedas which are eternal source of all knowledge and wisdom.[1-5] Vedic Mathematics is a boon for whole mankind which may be exhausted for scientific and technical purposes.[6-10] In present work, the recurring decimals are evaluated for denominators containing any number of digits 0 with 1 at unit place like 2001, 30001...; and digit 9s like 1999, 39999... for all possible numerators (numerator < denominator) in decimal system. The Sutras "*Ekadhikena Purvena* (One greater than the previous one)" and "*Ekanyunena Purvena* (One less than the previous one)" and Upsutra "*Anurupyena* (By Ratio)" are used extensively for this study. Some suitable programs are written and executed for evaluation of recurring decimals. These programs can be utilized for other fractions (denominator containing n-digits). The results thus obtained are tabulated, discussed and concluded.

TERMINOLOGY

1. Digit, Base and Base Number

Each and every number system contains digits from 0 (zero) to (X-1). So

$$S_{10} = \{0, 1, 2 \ldots 9\}; X = 10;$$

where 10 and 9 are the base and highest digit of the number system.[11] 10^n is called base number ($n \geq 2$). The scale or weight of each position in all number systems is as follows:

$$\ldots X^4 X^3 X^2 X^1 X^0 . X^{-1} X^{-2} X^{-3} \ldots$$

2. Positive, Negative and Bar Digits

(i) 0, 1, 2… 9 are called positive digits.[12]

(ii) -0, -1, -2, . . – 9 are known as negative digits.

(iii) When minus sign is used on the top of the digits as a, $a \in S_{10}$, the bar digits are obtained.

3. Simple Number and Compound Number

(i) Any number containing only positive digits is known as *Simple Number.*[13]

(ii) Any number which consists of positive and bar digits is called *Compound Number*.

4. Transformation of Simple Number into Compound Number

Any number which contains such digits which are greater than or equal to 5 are transformed as follows:[14]

Procedure

(1) Determine the groups of digits of the number which are greater than or equal to 5.

(2) Subtract all digits of group from highest digit and last digit of group from base. These are bar digits.

(3) The left side digit from the group is raise by one.

(4) Repeat the steps (2) and (3) for each and every group.

5. Transformation of compound Number into simple Number

When a number contains bar digits, one can transform it into simple number as given below:

Procedure

(1) Determine whether extreme left digit (digit of highest position) of the number is bar digit or not.

(2) If yes, take the minus on left side from the number and transpose the sign of each and every digit of the number.

(3) If not, then step (4).

(4) Determine the bar digit groups.

(5) Subtract all digits of group from highest digit and last digit of group from base. These are positive digits.

(6) The left side digit from the group is lowered by one.

(7) Repeat the steps (5) and (6) for each and every group.

6. Duplex and parameter

The value of each position is called duplex. It is evaluated from X^0 to X^n with the help of parameter.

RECURRING DECIMAL

If any digit or group of digits in a number repeats itself, the number is called recurring decimal.

1. If last Digit of Denominator is One

In this method, such type of fractions whose denominator's last digit is one, are studied as follows:

Procedure

(1) Subtract one from denominator. Count number of zeros in the difference. The number except zeros in difference is known as parameter. Taking Parameter negative, the evaluations are done.

(2) In recurring decimal, write digits of numerator taking bar on right side. The number of digits should be equal to the number of zeros in the difference. Extra digits are written on left below the first group. Increase zeros if number of digits is less.

(3) Evaluate duplex for left position or group of position.

(i) Duplex for left position = Parameter X Right group of digits + Extra digits.

(ii) Repeat step 3 (i) till the group of digits repeats itself.

Problem1: Obtain recurring decimal for 1/101.

Solution: Fraction = 1/101, Denominator = 101, Difference = 101-1 = 100,

Number of zeros = 2, Parameter = 1, Right digit = 01

Duplex = 01*01 01* 01

1/101 = 0.01 01

= 0.00 99

Some results are given in Table 1 for denominators 101 -8101.

2. If Last digit of Denominator is Highest Digit

In this method, such type fractions whose denominator's last digit is highest digit are studied, as given below:

Procedure

(1) The denominator is raised by one. Count number of zeros in the sum. The number except zeros in the sum is called parameter.

(2) In recurring decimal, write digits of numerator on right side. The number of digits should be equal to the number of zeros in the sum. Extra digits are written on left side below the first group increase zeros if number of digits is less.

(3) Evaluate duplex for left position or group of position.

(i) Duplex for left position = parameter X Right group of digits + Extra digits.

Write the duplex on left side as in step (2)

(ii) Repeat 3 (i) till the group of digit repeats itself.

Problem 2: Evaluate the fraction 1/399.

Solution: Fraction = 1/399, Denominator = 399, Sum = 399+1 = 400, Number of zeros = 2

Parameter = 4, Right digit = 01

Duplex = 25*40 6*4+1 26*4+2 56*4+2 64*4 16*4 4*04 4*01 01

100 25 106 226 256 64 16 04 01

1/399 = 0.00 25 06 26 56 64 16 04 01

= 0.00 25 06 26 56 64 16 04 01

Some results are shown in Table 2 for denominators 199 -10099.

DISCUSSION

The steps of evaluations are reduced to the extreme extent. The speed of calculations and accuracy of results are increased immensely. The complications of computations are reduced to the great extent. The quantum of operations is increased while the quantity of operations is reduced proportionately. Its pattern recognition is quick and most efficient. The number of digits in recurring decimals will also be reduced converting the number into another suitable number system. Each and every digit of recurring decimal has certain relationship with highest digit of the number system. In view of above inferences and methods, software can be developed and hardware will be modified to save the computer time.

ACKNOWLEDGEMENTS

The authors are thankful to Defense Research and Development Organisation, New Delhi (India) for financial assistance to this valuable work.

REFERENCES

1. RVSS Avadhanulu, *Vedas and Computers*, Shri Veda Bharati, Hyderabad, 2001.
2. T.S. Bhanu Murthy, *a Modern Introduction to Ancient Indian Mathematics*, Wiley Eastern Limited, New Delhi, 1992.
3. S.D. Satwalekar, *Yajurveda*, Swadhayaya Mandal, Killa Pardi, 1996.
4. RVSS Avadhanulu, *Aspects of Science and Technology in Vedas and Sastras*, Shri Veda Bharati, Hyderabad, 2005.

5. C. Santhamma, *Lecture notes on Vedic Mathematics of Shri B. K. Tirth*, Bharatiya Vidya Kendram, Visakhapatnam, 2004.

6. B.K. Tirth, *Vedic Mathematics*, Motilal Banarsidass, New Delhi, 1965.

7. B. B. Datta and A. N. Singh, *History of Hindu Mathematics*, Bharatiya Kala Prakashan, New Delhi, 2004.

8. K. Williams, *Astronomical Application of Vedic Mathematics*, Motilal Banarasi Dass, New Delhi, 2003.

9. A.W. Vyawahare, S. M. Chouthaiwale and S. S. Borgaonkar, *Introduction to Vedic Mathematics*, Swadhayaya Mandal, Killa, Pardi, 2003.

10. R. N. Arya and R. Prasad, Science *and Technology in Ancient India*, Vijnana Bharati, Mumbai, 2002.

11. Kailash, Divisibility and Recurring Decimals, CSI Communications (Computer Society of India), 19,11-14, 33, 1995.

12. Kailash, Divisibility (Decimal System), School Science, (NCERT, New Delhi) 33, 28-32, 1995.

13. Kailash, Fast Evaluation of Recurring Decimals (Decimal System), School Science, (NCERT, New Delhi), 33, 50-54,1995.

14. Kailash and A.K. Sharma, Sodash Ankiya Pranali mein Guran avam Vedic Ganit Ke Sutron avam Upsutron Ki Upadeyata, Bhartiya Scientest and Audhogik Anusundhan Patrika, (New Delhi), 12, 119-124, 2004.

15. Kailash, Program for Recurring Decimals, Rajasthan Board Journal of Education, 46-47, 73-76, 2005.

16. Kailash &A.K. Sharma, Power of Numbers, Rajasthan Board Journal of Education, 46-47, 10-21. 25, 2005.

Table1: Recurring decimals for denominator containing 1 at unit place

S.No	N	D	RN	S.No	N	D	RN
1	1	101	4	41	1	4101	1366
2	1	201	33	42	1	4201	75
3	1	301	42	43	1	4301	176
4	1	401	200	44	1	4401	81
5	1	501	166	45	1	4501	642
6	1	601	300	46	1	4601	1113
7	1	701	700	47	1	4701	1566
8	1	801	44	48	1	4801	800
9	1	901	208	49	1	4901	1092
0	1	1001	6	50	1	5001	833
11	1	1101	366	51	1	5101	1700
12	1	1201	200	52	1	5201	2226
13	1	1301	1300	53	1	5301	90
14	1	1401	233	54	1	5401	490
15	1	1501	234	55	1	5501	5500
16	1	1601	200	56	1	5601	933
17	1	1701	54	57	1	5701	5700
18	1	1801	900	58	1	5801	1450
19	1	1901	380	59	1	5901	84
20	1	2001	308	60	1	6001	32
21	1	2101	190	61	1	6101	1220
22	1	2201	105	62	1	6201	78
23	1	2301	96	63	1	6301	6300
24	1	2401	2058	64	1	6401	129
25	1	2501	60	65	1	6501	98
26	1	2601	272	66	1	6601	330
27	1	2701	24	67	1	6701	6700
28	1	2801	1400	68	1	6801	1133
29	1	2901	322	69	1	6901	1122
30	1	3001	1500	70	1	7001	1750
31	1	3101	1326	71	1	7101	786
32	1	3201	96	72	1	7201	378
33	1	3301	3300	73	1	7301	3108
34	1	3401	1602	74	1	7401	137
35	1	3501	388	75	1	7501	576
36	1	3601	138	76	1	7601	230
37	1	3701	3700	77	1	7701	1200
38	1	3801	180	78	1	7801	1876
39	1	3901	1886	79	1	7901	7900
40	1	4001	500	80	1	8001	42
				81	1	8101	44

N = Numerator, D = Denominator, RN = No. of digits in RD

Table2: Recurring decimals for denominator containing 9 at unit place

S.No.	N	D	RN	S.No	N	D	RN
1	1	199	99	51	1	5199	866
2	1	299	66	52	1	5299	54
3	1	399	18	53	1	5399	2699
4	1	499	498	54	1	5499	138
5	1	599	299	55	1	5599	508
6	1	699	232	56	1	5699	230
7	1	799	368	57	1	5799	21
8	1	899	420	58	1	5899	2768
9	1	999	3	59	1	5999	2568
10	1	1099	78	60	1	6099	954
11	1	1199	108	61	1	6199	3099
12	1	1299	432	62	1	6299	94

13	1	1399	699	63	1	6399	117
14	1	1499	214	64	1	6499	1056
15	1	1599	30	65	1	6599	3299
16	1	1699	567	66	1	6699	84
17	1	1799	768	67	1	6799	522
18	1	1899	30	68	1	6899	6898
19	1	1999	999	69	1	6999	583
20	1	2099	2098	70	1	7099	1140
21	1	2199	61	71	1	7199	3432
22	1	2299	198	72	1	7299	810
23	1	2399	1199	73	1	7399	1050
24	1	2499	336	74	1	7499	7498
25	1	2599	1232	75	1	7599	592
26	1	2699	2698	76	1	7699	7698
27	1	2799	155	77	1	7799	708
28	1	2899	222	78	1	7899	2632
29	1	2999	1499	79	1	7999	1260
30	1	3099	1032	80	1	8099	132
31	1	3199	456	81	1	8199	455
32	1	3299	3298	82	1	8299	1344
33	1	3399	34	83	1	8399	339
34	1	3499	318	84	1	8499	2832
35	1	3599	1740	85	1	8599	1433
36	1	3699	24	86	1	8699	8698
37	1	3799	1820	87	1	8799	1254
38	1	3899	834	88	1	8899	202
39	1	3999	105	89	1	8999	4499
40	1	4099	4098	90	1	9099	336
41	1	4199	144	91	1	9199	4599
42	1	4299	1055	92	1	9299	1456
43	1	4399	533	93	1	9399	30
44	1	4499	204	94	1	9499	1914
45	1	4599	24	95	1	9599	1540
46	1	4699	42	96	1	9699	780
47	1	4799	2399	97	1	9799	35
48	1	4899	770	98	1	9899	468
49	1	4999	357	99	1	9999	4
50	1	5099	5098	100	1	10099	3366