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Kaprekar's Constant 6174 for Four Digits Number Reality to Other Digits Number

Dr. Pijush Kanti Bhattacharjee

Department of Electronics & Communication Engineering, Camellia Institute of Technology & Management, Bainchi, Hooghly, West Bengal, Pin-712134, India.

Abstract— *Indian mathematician Kaprekar discovered a constant or dead end 6174 for four digits decimal number when the digits in the number are not repeated, ascending order digits number is subtracted from descending order digits number, and the result is further processed likewise till constant 6174 reached. All the subtraction results are divisible by 9 and 3 without any remainder. In the same way, constant or dead end is discovered for two digits number as 9, three digits number as 495, ten digits number as 9753086421 and for binary number as 01 or 1.*

Keywords— ***Kaprekar's constant 6174; Two digits number constant 9; Three digits number constant 495; Ten digits number constant 9753086421; Binary number constant 01 or 1.***

I. INTRODUCTION KAPREKAR'S CONSTANT

6174 is the number discovered by an Indian mathematician, Dattatreya Ramchandra Kaprekar [1] – [2]. It is called magic number. By looking at the number you will not feel anything weird, but has pleasantly mesmerized several learned mathematicians no ends. From the year 1949 till now, this number has remained a puzzle for all around the world.

Indian mathematician Dattatreya Ramchandra Kaprekar loved experimenting with numbers. In the process of one of his experiments, he discovered a bizarre coincidence and during a 'Mathematics Conference' held in erstwhile Madras in the year 1949, Kaprekar introduced this number 6174 to the world.

To understand why this number is so magical let's look at some interesting facts. For example, choose any decimal number of four digits keeping in mind that no digit is repeated. Let's take 1234 for example. Write the number in descending order: 4321. Now write in ascending order: 1234. Now subtract the smaller number from the large number: 4321 – 1234 = 3087.

Now the result again is arranged in descending and ascending order. For 3087, place the digits in decreasing order: 8730. Now place them in increasing order: 0378. Now subtract the smaller number from the large number, we get, 8730 – 0378 = 8352. Repeat the above procedures with the number found in the result. So, 8532 – 2358 = 6174. Let us repeat this process with 6174. The result is given by, 7641 – 1467 = 6174.

We have reached a dead end and there is no point repeating the process, since we will get the only one result 6174. If you think that this is just a coincidence, repeat this process with any other four digits decimal number. Voila! Your final result will be 6174. This formula is called Kaprekar's constant. Also the subtraction results are completely divisible by 9 and 3 having no remainder.

In a computer based experiment a gentleman named Nishiyama discovered that the Kaprekar process reached 6174 in a maximum of seven stages [3]. According to Nishiyama, 'If you do not reach 6174 even after repeating the process seven times, then you must have made a mistake and you should try again'.

However, almost all renowned mathematicians of the era mocked his discovery. Some Indian mathematicians rejected his work and termed his theory childish. In time, discussions of this discovery slowly started gaining foothold both in India and abroad. Martin Garder, America's best-selling author with deep interest in mathematics wrote an article about him in "Scientific America", a popular science magazine. Today, Kaprekar is regarded a mathematical wizard and his discovery is slowly gaining traction. Intrigued Mathematicians all over the world are engrossed in researching this baffling reality.

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II. RESULTS BY KAPREKAR'S PROCESS FOR OTHER DIGITS NUMBER

A decimal number, containing digits 0 to 9 only and having the base 10, is chosen such that no digit is repeated as taken in Kaprekar's procedure. Then digits in the number are arranged in ascending and descending order. Thereafter, the ascending order digits number is subtracted from the descending order digits number, it is seen that the subtraction results are always divisible by 9 and 3 with no remainder. We have seen that in any number, if the sum of the digits is 9, then the number is completely divisible by 9 and 3 without any remainder.

(A) Two Digits Number Subtracted Ascending Order from Its Descending Order

The following experiments are done on two digits decimal number, where no digit is repeated.

(i) If two digits number 30 is taken, then 30 – 03 = 27; repeating the process, 72 – 27 = 45; 54 – 45 = 9; Dead or last end is reached to 9; all the subtraction results are completely divisible by 9.

(ii) If two digits number 23 is chosen, then 32 – 23 = 9, dead end is reached and the result is divisible by 9.

(iii) If two digits number 48 is selected, then 84 – 48 = 36. If continuing the process with the result, 63 – 36 = 27; 72 – 27 = 45; 54 – 45 = 9; i.e., ultimately it is merging to 9. Therefore, 9 is the dead end for two digits number. All the subtraction results are completely divisible by 9.

It is also verified that when all two digits number (not repeating digits) are arranged in ascending and descending order, thereafter subtracting the ascending order number from the descending order number, the result must be divisible by 9 without any remainder, if the process is repeated, at last we will reach to number 9 which is the dead end or constant for this system of two digits number like Kaprekar's constant 6174 for four digits number.

(B) Three Digits Number Subtracted Ascending Order from Its Descending Order

Next if the decimal number is chosen for three digits where no digit is repeated, following results are obtained and all the subtraction results are completely divisible by 9.

(i) The number is 710, 710 – 17 = 693; 963 – 369 = 594; 954 – 459 = 495; If we repeat, we will get same result as 495; Therefore, 495 is dead end for three digits number. Again, all the subtraction results are divisible by 9. Also, 4 + 9 + 5 = 18; 1 + 8 = 9; Thus 495 is completely divisible by 9.

(ii) The number is 123, 321 – 123 = 198; If the process is repeated with the result, then 981 – 189 = 792; 972 – 279 = 693; 963 – 369 = 594; 954 – 459 = 495; Thus 495 is the last stage or dead end for three digits number. All the subtraction results are completely divisible by 9.

(iii) The number is 963, 963 – 369 = 594; 954 – 459 = 495; Thus final stage 495 is reached.

All the subtracting results are completely divisible by 9. Therefore, for three digits number, the dead end or constant is 495, i.e., ultimately we will reach to 495 when this process continues; hence it will merge to 495 as last stage.

(C) Four Digits Number Subtracted Ascending Order from Its Descending Order

For four digits decimal number, Kaprekar's constant 6174 is already discovered as a dead end or constant. Therefore, mathematician Kaprekar revealed a great land mark by identifying the constant 6174 for four digits number first time.

(D) Five Digits to Nine Digits Number Subtracted Ascending Order from Its Descending Order

For five digits to nine digits decimal number, when the digits are not repeated, and it is seen that an ascending order digits number is subtracted from the descending order digits number, in most of the times the some digit/digits are repeated in the subtraction result (only in very few subtraction results, the digits are not repeated), therefore it cannot be continued for further processing, but all the subtraction results are divisible by 9 without any remainder. Following examples are mentioned below.

(i) For five digits number 12345, 54321 – 12345 = 41976, then continuing, 97641 – 14679 = 82962; digit 2 is repeated.

(ii) For five digits number 12346, 64321 – 12346 = 51975; digit 5 is repeated.

(iii) For five digits number 12349, 94321 – 12349 = 81972; further continuing, 98721 – 12789 = 85932; 98532 – 23589 = 74943; digit 4 is repeated.

(iv) For six digits number 123458, 854321 – 123458 = 730863; digit 3 is repeated.

(v) For seven digits number 2345678, 8765432 – 2345678 = 6419754; digit 4 is repeated.

(vi) For eight digits number 12345678, 87654321 – 12345678 = 75308643; digit 3 is repeated.

(vii) For nine digits number 023456789, 987654320 – 23456789 = 964197531; digits 1 and 9 are repeated.

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Hence, it is observed that Kaprekar's procedure cannot be continued for numbers having digits from five to nine due to some digits are repeated. It is a surprising thing that the subtraction results are always divisible by 9 having no remainder. Hence, there is no dead end or lock stage, i.e., constant found for five digits to nine digits numbers.

(E) Ten Digits Number Subtracted Ascending Order from Its Descending Order

It is a beautiful thing that ten digits number, in which the digits are not repeated, dead end or lock stage is obtained by first subtraction. In decimal numbering system, the ten digits decimal number is 0123456789 where the digits are not repeated. Now arranging the ten digits number in ascending and descending order and then subtracting the ascending order digits number (smaller) from the descending order digits number (larger), we get, 9876543210 – 0123456789 = 9753086421. If we further continue, the same result will be obtained. Thus the dead end or constant for ten digits number is 9753086421. It is amazing fact that adding all digits, 0 + 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 = 45; 4 + 5 = 9; Hence, it is completely divisible by 9. Also the ten digits number without repeating the same digit is the last or end number in decimal numbering system.

(F) Octal and Hexadecimal Numbering System

Octal number system is taken digits from 0 to 7, and the base is 8. Hexadecimal number system is same as decimal number system, only the digits in a number is extended up to fifteen like 0 to F and the base is 16, where A = 10, B = 11, C = 12, D = 13, E = 14, F = 15. Therefore, for octal and hexadecimal numbering systems like Kaprekar's procedure are adopted as similar to decimal numbering system.

(G) Binary Numbering System Subtracted Ascending Order from Its Descending Order

A binary number is represented by two digits such as 0 and 1, and the base is 2. If the digits are not repeated, then the binary number is expressed as descending order 10 and ascending order 01, then subtracting ascending order binary number from descending order binary number, we get, 10 – 01 = 01, thus 01, i.e., 1 is the dead end or constant in case of binary numbering system. Moreover, 01 is the 1's complement of 10. Since, 1 is the highest digit in binary numbering system, the dead end 1 is divisible by 1 also.

III. CONCLUSION

It is an astonishing fact that in decimal number system, the ascending order digits number are subtracted from the descending order digits number (where the digits are not repeated), the subtraction results are always divisible by 9 having no remainder which is the highest digit in decimal system, and if the process continues like this ultimately we arrive a dead end or lock stage for two digits to four digits number and ten digits number. For four digits number, the dead end is already discovered by mathematician Kaprekar and it is called Kaprekar's constant 6174. In this paper, the dead ends for all other digits numbers are discovered with proper explanation.

Therefore, it is concluded that like Kaprekar's constant 6174 for four digits decimal number, the dead end or constant for two digits decimal number is 9, for three digits decimal number is 495 and for ten digits decimal number is 9753086421. In binary numbering system, the dead end or constant is 01 or 1.

Now-a-days for computerised algorithm and manipulation of huge or big data, this inherent knowledge for decimal and other numbering systems like binary, octal, hexadecimal etc. will be useful, and identify a precise way for mathematical computation.

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Dr. Pijush Kanti Bhattacharjee is associated with the study in Engineering, Management, Law, Indo-Allopathy, Herbal, Homeopathic, and Yogic Medicines. He is having qualifications Ph.D (Engg.), M.E, MBA, MDCTech, A.M.I.E (B.E or B.Tech), LLB, B.Sc, B.A, BIASM, CMS, PET, EDT, FWT, DATHRY, KOVID, DH, ACE, FDCI etc. He worked in Department of Telecommunications (DoT), Government of India as a Telecom Engineer from 1981 to 2007, then worked in different Engineering Colleges and Assam University [Central University], Silchar, India as Assistant and Associate Professor from 2007 to 2020. He has written fourteen books and more than hundred research papers. He is a Member of IACSIT, Singapore; CSTA, UACEE, USA; IAENG, IETI, Hongkong; and IE, ISTE, IAPQR, IIM, India. His research interests are in Telecommunications including Mobile Communications, Image Processing, VLSI, Nanotechnology, Electrical Power Systems, Power Electronics Circuits, Environmental Pollution, Medicine and Mathematics.