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Magic Hexagon of Order-4 with Star Configuration: A Study on Symmetry and Combinatorial Patterns

Himadri Maity
Student of class X,
Bangalpur U.C High school

Abstract- This paper presents a new magic hexagon of Order-4 with 24 cells, which exhibits a unique star configuration inside the hexagon. The hexagon follows distinct combinatorial patterns where all combinations of selected numbers result in equal sums. A total of 52 combinations are identified with a constant sum of 190, making this work significant in the study of mathematical patterns and symmetry.

Index Terms- Magic Hexagon, rotational symmetry

I. INTRODUCTION

Magic hexagons and magic squares have long been studied for their symmetrical properties and applications in number theory. The most famous example of a magic square was created by Srinivasa Ramanujan. However, this paper introduces a novel magic hexagon that integrates both the hexagonal shape and a star-shaped pattern.While the rest are arranged to maintain symmetry and equal sums across different paths.

II. METHODOLOGY

The construction of the hexagon began with placing numbers in 24 cells. Subsequent numbers were selected to ensure the sum across all valid combinations remained constant. A total of 52 combinations were found where each path— whether along the edges or diagonals of the hexagon—produced the sum of 190.The process followed systematic trial and error, ensuring that the numbers formed both a star and a hexagon and adhered to the magic properties. Mathematical reasoning, symmetry analysis, and combinatorial techniques were applied to verify the correctness of the final hexagon.

III. RESULTS

The final magic hexagon has 24 cells with a unique internal star-shaped pattern. A total of 52 combinations were identified with a constant sum of 190. The star configuration provided additional symmetry within the hexagon, and it was noted that the star's vertices corresponded to the vertices of the hexagon. The hexagon demonstrated the following key properties: Symmetry: The star configuration maintains rotational symmetry, aligning with the vertices of the hexagon. Combination of Paths: The total number of valid combinations yielding the same sum was 50, a unique feature compared to traditional magic hexagons.

Constant Sum
All paths, whether along the edges or diagonals, resulted in a sum of 190.

Discussion
This new magic hexagon opens up possibilities for exploring more complex combinatorial patterns and their applications in mathematical research. It also contributes to the study of symmetry and structure in mathematics, particularly in understanding how different shapes and numbers can interact to form consistent patterns.

Comparing this hexagon to other known magic figures, such as Ramanujan's magic square, we observe similarities in terms of the equal-sum property, but the introduction of a star configuration adds a novel twist. The discovery of 52 combinations also suggests that this structure has deeper combinatorial significance, which warrants further exploration.

Theory Advantages
The construction of this magic hexagon offers several advantages:-

- Enhanced Understanding of Geometric Symmetry.
- The arrangement combines both hexagonal and star-like symmetries, providing insights into complex geometric interactions.
- Potential Applications in Cryptography: Magic hexagons and similar mathematical constructs can be useful for designing cryptographic algorithms, where the consistency of sums across combinations can aid in encoding messages.

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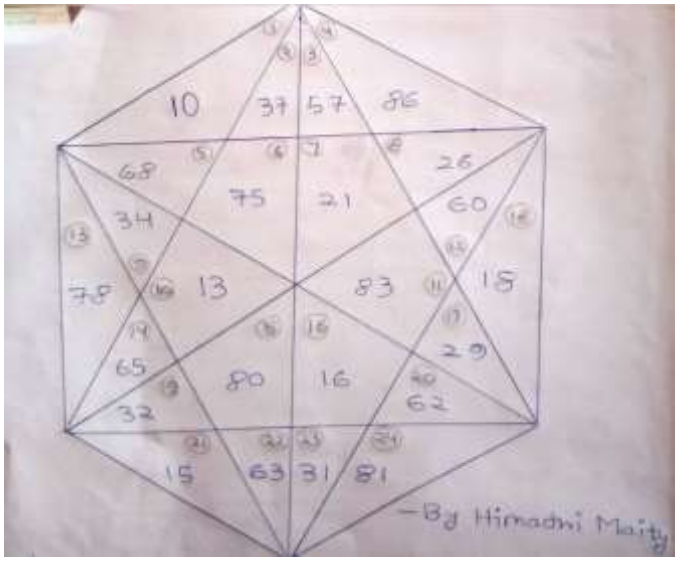

Combination:- 2,3,15,16
1,2,3,4
5,6,7,8
9,10,11,12
19,15,16,20
21,22,23,24
1,5,6,2
5,9,10,6
9,10,13,14
10,14,19,15
15,16,22,23
16,23,20,24
11,16,20,17
11,17,18,12
7,8,11,12
3,4,7,8
2,3,6,7
13,14,19,21
21,9,5,4
4,8,12,18
2,7,10,14
3,7,17,11
18,13,22,23
21,4,20,17
18,2,3,13
24,19,13,1
24,1,12,8
19,20,21,24
18,17,13,14
23,24,12,18
22,23,7,6
9,13,12,18
1,5,4,8
1,19,5,15
4,8,16,20
20,24,7,8
5,6,19,21
9,13,7,3
11,17,21,22
23,24,14,10
11,12,1,2
22,15,17,18
2,6,12,18
15,19,21,22
1,2,13,14
17,18,3,4
9,10,3,4
16,23,13,14
5,8,15,16
19,20,6,7
10,11,8,5
10,11,19,20

Here these numbers represents:- 1=10
2=37
3=57
4=96
5=68
6=75
7=21
8=26
9=34
10=13
11=83
12=60
13=78
14=65
15=80
16=16
17=29
18=18
19=32
20=62
21=15
22=63
23=31
24=81

If we addition real value of every 4 observations like this way written in a combination of observations, then the answer of addition will be 190 for each combination .

Educational Benefits: This construction serves as a valuable tool for teaching students about number theory, symmetry, and combinatorics. (4) Exploration of Mathematical Art:

The aesthetic appeal of the star-hexagon arrangement invites further exploration in the intersection of mathematics and art,inspiring creativity in both fields.

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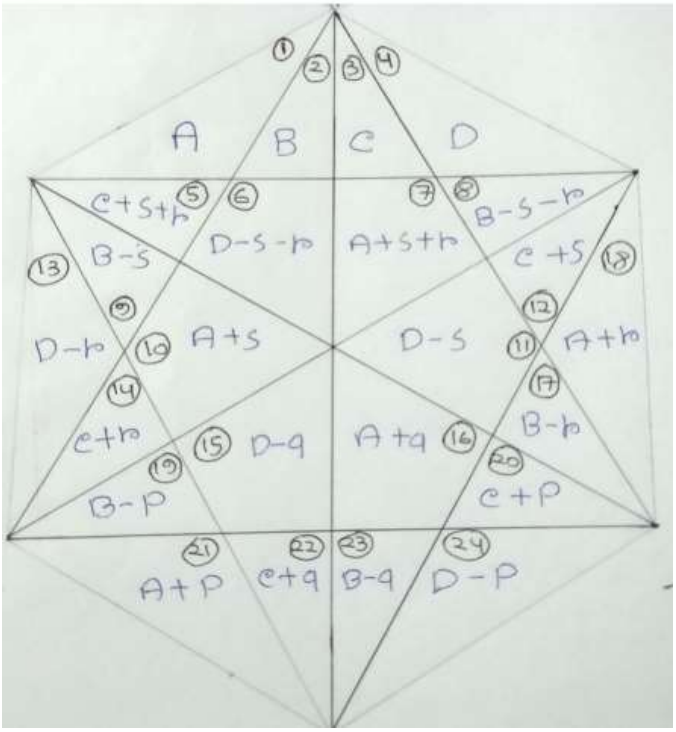
This is the formula to make this Here A,B,C,D,p,q,r,s is constant



IV. CONCLUSION

The creation of this magic hexagon with a star-shaped pattern marks a significant step in the exploration of mathematical symmetry and number theory. The study suggests that such structures could have applications in fields like cryptography, combinatorics, and mathematical modeling. Future research can explore larger hexagons or different geometric configurations, and their potential uses in scientific computation and theoretical mathematics.

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