# Generalization of Magic Square 

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#### Abstract

A magic square of order $3 n$ is $3 n \times 3 n$ matrix containing integers in such a way that each row and column add up to the same value. We generalize this notion to that of a $3 n \times 3 n$ matrix with the help of a special geometrical figure without having much knowledge of algebra and another branch of mathematics.


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## Introduction

Magic square always draw attention of human beings after the invention of zero by Arya Bhatt an Indian Mathematician. Then after, a long series of Mathematicians or Mathematics loving fellow enchanted their attention by showing and proving extremely lovable properties of square magic of various orders.
A magic square is a square array of numbers consisting of the distinct positive integers $1,2,3, \ldots, n^{2}$ arranged such that the sum of the $n$ numbers in any horizontal, vertical, or main diagonal line is always the same number (Kraitchik 1942, p. 142; Andrews 1960, p. 1; Gardner 1961, p. 130; Madachy 1979, p. 84; Benson and Jacoby 1981, p. 3; Ball and Coxeter 1987, p. 193), known as the magic constant

$$
M(n)=\frac{1}{n} \sum_{s=1}^{n^{2}} s=\frac{1}{2} n\left(n^{2}+1\right)
$$

If every number in a magic square is subtracted from $\left(n^{2}+1\right)$, another magic square is obtained called the complementary magic square. A square consisting of consecutive numbers starting with 1 is sometimes known as a "normal" magic square. From various source one can justified that for 3X3 a geometric figure has been discovered long ago, which is like with an example


For more knowledge one can visit the website http://mathworld.wolfram.com/MagicSquare.html.

Now we are interesting in some more properties of this geometrical figure that we can achieve the magic square for various orders with the same help of this geometry.

## Methodology and Main Results

If some one wants to make a square magic for 9 X 9 , it can be managed in the same way
Example 2:

## Our Process.

## Steps:

I.Fix the required total sum $369 \leq S<\infty$, which must be devisible by 9 . Let us say S .
II.Find the number

$$
C_{0}=\frac{S}{9}
$$

III.Find starting number

$$
I_{\alpha}=C_{0}-\alpha M_{0}, \alpha \in I
$$

,With difference $\alpha$.
IV.

$$
M_{0}=\left[\frac{\text { No. of Blocks of square in matrix }+1}{2}-1\right]
$$

V.Calculate the set of nine numbers with defined difference.
VI.Put the nine numbers according to the figure suggested here A=Starting Point

B = End Point

## Properties of our Process


I. We may obtain various strating number $\mathrm{I} \alpha$ for fix required sum.
II. We may obtain various strating number I $\alpha$ with different difference for fixed required sum.
III. We may get difference beetween numbers varrible.
IV. We may get different matrix with same set of numbers, with same differnce via rotating the direction of figure from strating to end point in clock wise or anit clock wise direction also we can change the strating and end point for getting different matrix.
V. We can find strating number and difference as per desire with the help of arithmetic progression, where

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Required Figure

| S.N. | Required Sum | Number to creat starting number | Starting Number | Common Difference |
| :--- | :--- | :--- | :--- | :--- |
| 1 | 369 | 41 | $41-40=1$ | 1 |
| 2 | 378 | 42 | $42-40=2$ | 1 |
| 3 | 720 | 80 | $80-40=40$ | 1 |
| 4 | 729 | 81 | $81-40=41$ | 1 |
| 5 | 729 | 81 | $81-2 * 40=1$ | 2 |
| 6 | 765 | 85 | $85-40=45$ | 1 |
| 7 | 765 | 85 | $85-2 * 40=5$ | 2 |
| 8 | 1089 | 121 | $121-40=81$ | 1 |
| 9 | 1089 | 121 | $121-2 * 40=41$ | 2 |
| 10 | 1089 | 121 | $121-3 * 40=1$ | 3 |

$S=\frac{n}{2}[2 a+(n-1) d]=\operatorname{Re}$ quiredsum $\times 9$
Where $\mathrm{n}=81$ for $9 \times 9$ matrix $\mathrm{a}=$ starting number $\mathrm{d}=$ difference.
VI. So, we can start for finding magic square either with required sum or starting point or with difference or with rotation of figure.
VII. In this method, we may use zero or negative integer in property V for filling of magic square matrix.
VIII. $C_{0}$ always coming centre point.

## Discussion on Applications

Magic squares are useful in cryptography for coding and decoding the message in secured manner with complete integrity. The concept of balancing the magical squares with the help of suggested geometrical figure is easy and perfect. This is a new concept for magical squares. It is being used for moving bodies, Rotors, Cam shaft, Crank shaft etc.

## Some More Discussion

1. On the same line with the help of same geometry and management one can obtain magic square of $3 \times 3,3^{2} \times 3^{2}$, $\left[3^{2}\right]^{2} \times\left[3^{2}\right]^{2}, \quad\left[\ldots\left[3^{2}\right]^{2} \ldots .\right]^{2} \times\left[\ldots\left[3^{2}\right]^{2} \ldots . .\right]^{2}$ or simply one can say $3^{n} \times 3^{n}, n \in I$.
2. One can separately arrange square of 9 or 81 or $81^{2} \times 81^{2}$ or $\ldots$., into 3 X 3 square fill it from starting number, then get starting
number for another 3 X 3 square and on the same line complete all. Finally, arrange according to suggested geometry on the whole square and get square magic.
3. It is workable only in the case of 9X9 blocks or multiple of nine blocks.

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