

TsinghuaX: 60240013x Combinatorial Mathematics

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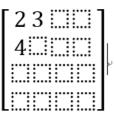
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**G1** (1/1 point)

The figure below shows a partial 4X4 matrix, is there some way of filling up the rest of the omitted entries to produce a magic square of size 4?

o yes

no 🗸



#### **EXPLANATION**

If there is some way of producing a magic square of size 4:

[ 23ab | 4cde | f 9 h ..... | k ]

then 1≤a,b,c,d,e,f,g,h,i,j,k≤16 and a,b,c,d,e,f,g,h,i,j,k do not equal to each other

the magic sum of size 4 is:  $\, rac{n*(n^2+1)}{2} = 34$  ,

Taking the sum of the first row and first column respectively:

$$\begin{cases} 2+3+a+b = 34 \\ 2+4+f+i = 34 \end{cases}$$

so that

- 1) if a,b are equal to 13,16, respectively, then we cannot find f,i such that the sum of the two is equal to 28 (14+14, 15+13 and 12+16 are all impossible)
- 2) If a and b are equal to 14 and 15, and f and i are equal to 12 and 16, taking the sum of the second row, second column and the anti-diagonal respectively:

$$\begin{cases} 4+c+d+e = 34\\ 3+c+g+j = 34\\ 2+c+h+k = 34 \end{cases}$$

for which c,d,e,g,j,h,k $\in$ {1,5,6,7,8,9,10,11,13},taking the sum of the equations 9+3c+d+e+g+h+j+k=102, so if c=13, d+e+g+h+j+k=54, but 11+10+9+8+7+6<54, contradiction. The same is true for c smaller than 13.

Combining our results from 1) and 2), we see that our assumptions cannot hold, so it is impossible to construct a magic square of size four with the given conditions.

**Hide Answer** 

You have used 1 of 1 submissions

# G2 (1/1 point)

Which number below, if used as the magic sum, allows us to construct magic squares of size 3, using only non-repeated natural numbers?

- 0 12
- 23
- 18
- 34
- 0 20

#### **EXPLANATION**

Let's first create a magic square of size 3

M1.₽	M2.	M3.	Ç
M4.	<b>M</b> 5₽	M6.₽	Ç
M7₽	<b>M</b> 8₽	M9.₃	Ç

we assume the value of to add elements in each row/column/diagonal is k, we have:

$$\left\{egin{array}{l} M_1+M_5+M_9=k \ M_2+M_5+M_8=k \ M_3+M_5+M_7=k \end{array}
ight.$$

then we add the three equation together

$$M_1 + M_2 + M_3 + 3M_5 + M_7 + M_8 + M_9 = 3k(1)$$

besides,

$$\left\{egin{aligned} M_1 + M_2 + M_3 &= k \ M_7 + M_8 + M_9 &= k \end{aligned}
ight.$$

put these two equation into (1),we have $M_5=rac{k}{3}$ 

as a result, k must be natural numbers for k to be multiples of 3.

the least k of magic square is 15, so only 18 is possible



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