Maths Lab Class
DST INSPIRE Science camp 2016
NIT Silchar

Debashish Sharma
Assistant Professor, Department of Mathematics, Gurucharan College Silchar
Ajoy Dutta
PhD Scholar, Department of Mathematics, NIT Silchar

Day 1

1. Complete the composition table for the Dihedral Group of order 8 using the coloured square as described.

Complete the following composition table using the motions as described :

		R_0	R_{90}	R_{180}	R_{270}	H	V	D_1	D_2
	R_0								
	R_{90}								
	R_{180}								
	R_{270}								
	H								
	V								
	D_1								
	D_2								

2. Construct all possible 3×3 magic squares with the numbers from 1 to 9. Can you apply the idea of Dihedral group to find all possible magic squares.

3. Complete the given 4×4 magic square given in Figure 1. What is the magic sum in an $n \times n$ magic square?

	1		7
	8		2
5		3	
4		6	9

Figure 1

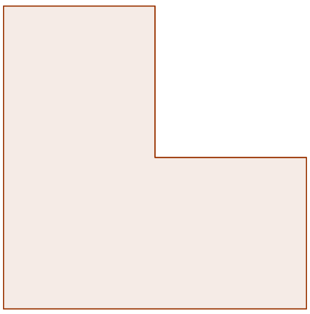


Figure 2

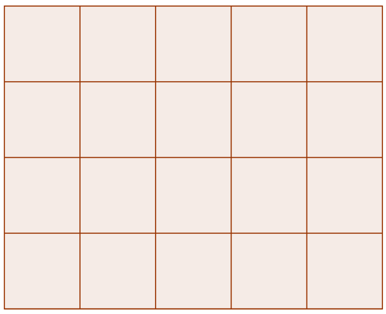


Figure 3

4. Cut the figure 2 into four figures, each similar to the original and with dimensions twice as small.

5. Illustrate the identity $1 + 2 + 3 + \ldots + n = \dfrac{n(n+1)}{2}$ using a rectangular grid of the type given in figure 3.

6. Activity on some interesting properties of Mobius strip.

7. Show that given any 6 integers, there always exist two integers whose difference is divisible by 5.

8. In how many ways can you climb 12 steps of an ordinary staircase if you are allowed to take either one step or two steps at a time? (Leonardo's leaps)

9. The numbers through 1 to 15 are written in a row. Two players take turns putting + and − signs between the numbers. When all such signs have been placed, the resulting expression is evaluated. The first player wins if the sum is even and the second player wins if the sum is odd. Who will win?

Day 2

1. Activity on some interesting properties of Mobius strip.
2. Two players take turns placing rooks (castles) on a chessboard so that they cannot capture each other. The loser is the player who cannot place a castle. Who will win?
3. Cut a square into five rectangles in such a way that no two of them have a complete common side (but may have some parts of their sides in common).
4. Complete the composition table for the Dihedral Group of order 8 using the coloured square as described.

Complete the following composition table using the motions as described :

		R_0	R_{90}	R_{180}	R_{270}	H	V	D_1	D_2
	R_0								
	R_{90}								
	R_{180}								
	R_{270}								
	H								
	V								
	D_1								
	D_2								

5. Construct all possible 3×3 magic squares with the numbers from 1 to 9. Can you apply the idea of Dihedral group to find all possible magic squares.

14	1		7
	8		2
5		3	
		6	9

Figure 1

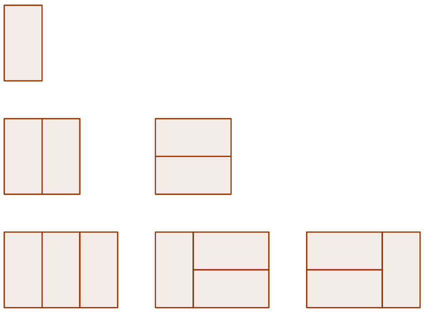


Figure 2

6. Complete the given 4×4 magic square given in Figure 1. What is the magic sum in an $n \times n$ magic square?
7. You are given bricks of length 2 units and breadth 1 unit as shown in figure 2. You are to construct a wall of height two units length 10 units, placing the bricks in any of the following ways. In how many ways can you do that ? (Brick wall pattern problem) Some examples are given in figure 2 above.

Day 3

1. A circle is divided into 6 sectors and an object is placed in each one of them. The task is to gather all the objects into one sector under the restriction of exactly one type of move in each turn. The move consists of shifting any two objects to any of their respective adjacent sectors. Is this possible ? Give it a try.

2. Show that if any numbers are chosen from the set $\{1, 2, \ldots, 2n\}$, then there will always exist two numbers which differ by 1.

3. Complete the composition table for the Dihedral Group of order 8 using the coloured square as described.

Complete the following composition table using the motions as described :

		R_0	R_{90}	R_{180}	R_{270}	H	V	D_1	D_2
	R_0								
	R_{90}								
	R_{180}								
	R_{270}								
	H								
	V								
	D_1								
	D_2								

4. How many $1 \times n$ designs can you make using tiles of lengths 1 unit and 2 units in any possible order? Some examples are given :

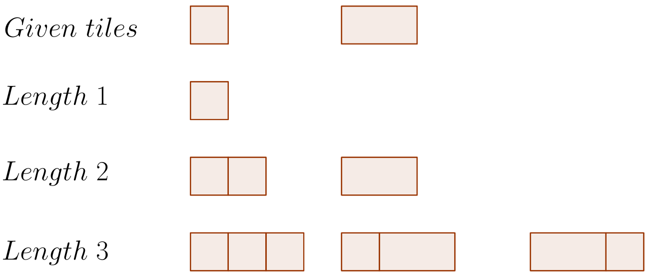


Figure 1

5. Construct all possible 3×3 magic squares with the numbers from 1 to 9. Can you apply the idea of Dihedral group to find all possible magic squares?

6. Ten 1's and ten 2's are written on a blackboard. Two players take turns in erasing any two numbers written on the board i.e in each turn a player deletes any two numbers. If the two numbers erased are identical, they are replaced with a 2. If they are different, they are replaced by 1. The first player wins if a 1 is left and the second player wins if a two is left. Who will win?

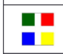
1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2

7. Activity on some interesting properties of Mobius strip.

Day 4

1. Complete the composition table for the Dihedral Group of order 8 using the coloured square as described.

Complete the following composition table using the motions as described :

		R_0	R_{90}	R_{180}	R_{270}	H	V	D_1	D_2
	R_0								
	R_{90}								
	R_{180}								
	R_{270}								
	H								
	V								
	D_1								
	D_2								

2. Construct all possible 3×3 magic squares with the numbers from 1 to 9. Can you apply the idea of Dihedral group to find all possible magic squares.

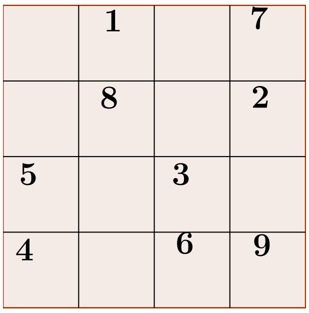


Figure 1

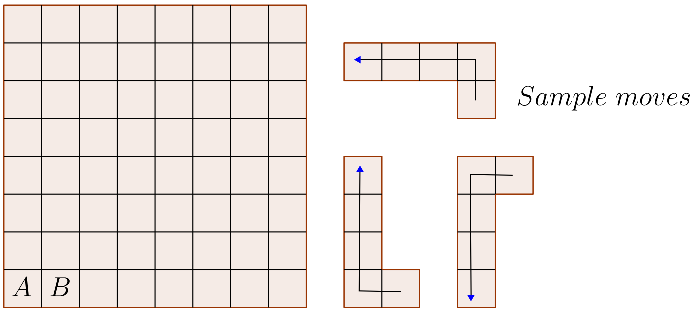


Figure 2

3. A special chess piece called a "camel" moves along a board like a $(1, 3)$ knight i.e. in one move it first goes to any adjacent square and then another three squares in any perpendicular direction (See figure 2 above). Starting from the square A, make successive moves so that the camel reaches the adjacent square B. Is it possible to reach B?

4. Activity to demonstrate Pigeonhole principle : Can you join each of the six points, given in Figure 1, with each of the other five points with a red line or a blue line in such a way that you should not get any triangle (with given points as its vertices) having all sides having the same colour ?

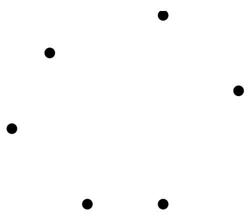


Figure 1

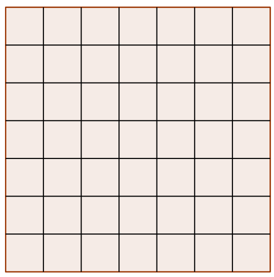


Figure 2

5. Illustrate the identity $1 + 3 + 5 + \ldots + (2n - 1) = n^2$ using a square grid of the type as in figure 2 above.

6. Activity for Kaprekar's constant - Take any 4 digit number with at least two different digits. Perform the following task : Arrange the digits of this number in descending order and write it as another 4 digit number, say D. Arrange the digits of the original number in ascending order and write it as another 4 digit number, say A. Compute the difference and write it as another 4 digit number, say N (Adding leading zeros if necessary). Repeat the same steps with N. Do this at least 8 times. Be careful with your calculations. This is important !

7. Activity on some interesting properties of Mobius strip.