**Coding and Decoding using Matrices**

This part of the investigation will show you by example how to produce a coded message (enciphering) and how to decode a message (deciphering).

The 26 letters of the alphabet are chosen and a value assigned as show below:

Letters: A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Value: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 0

Assign numbers to some plain text and then arrange these numbers in column matrices. For example:

ALGEBRA becomes AL GE BR AA and with code and column matrix form becomes

To encipher this message or word we need a coding matrix which is a 2x2 matrix with a determinant that is not divisible by 2 or 13.

An example is. Pre-multiply each column matrix by this 2x2 matrix. For example,

. AL has been enciphered as KN.

This gives an enciphered message of KNVSDVDC.

To decipher a code with the enciphering matrix known, rewrite the code in number form and produce column matrices. Then with the enciphering matrix, find its determinant and then the reciprocal modulo 26 of that number. For example, consider the enciphering matrix which has a determinant of 5. This has a reciprocal modulo 26 value of 21. The following table will help with other values for the determinant:

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Determinant and the reciprocal modulo 26 | | | | | | | | | | | | |
| Determinant | 1 | 3 | 5 | 7 | 9 | 11 | 15 | 17 | 19 | 21 | 23 | 25 |
| Reciprocal modulo 26 | 1 | 9 | 21 | 15 | 3 | 19 | 7 | 23 | 11 | 5 | 17 | 25 |

Now convert the enciphering matrix to a deciphering matrix:

Use this deciphering matrix to pre-multiply coded column matrices and hence decode the message.