**Matrix Algebra Operations**

The Microsoft Excel matrix functions are:

1. MDETERM( array) Returns the matrix determinant of an array
2. MINVERSE( array) Returns the inverse of the matrix of an array
3. MMULT(arrayA, arrayB) Returns the matrix product
4. TRANSPOSE(array) Returns the transpose of an array. The first row of the input array becomes the first column of the output array, etc.

Notes:

1. For all but TRANSPOSE( ), every cell in the array must contain a numeric value otherwise the #VALUE! error results.
2. The #VALUE! error results when an illegal matrix operation is attempted.
3. Because the first two functions use an accuracy of 16 digits, small numeric errors may occur. For example, a singular array may return a result that differs from zero by l E-16.
4. Except for MDTERM( ), these are array functions and must be completed with **Ctrl+Shift+Enter.**
5. If a matrix function returns a single value when a range of values was expected, you did not use **Ctrl+Shift+Enter**to complete the formula.

Before we use these functions, a quick review of matrix algebra.

1. A matrix with m rows and n columns is said to be of order m x n. When n and m are equal, the matrix is said to be square.
2. Matrix A is said to be identical to matrix B when every element in A equals the corresponding elements in B i.e. aij = bij. Clearly the two matrices must have the same order.
3. If A and B are of the same order, then A + B = C, and C has the same order as A and B. The elements in C are found using cij = aij+bij . Matrix subtraction is defined in a manner similar to addition.
4. If A is a matrix of order m x n and B is a matrix of order n x p (i.e. the number of columns in A equals: the number of rows in B), then the matrix product of A and B, AB, is defined and is a matrix of order m x p. If AB = C, then



Matrix multiplication is not commutative; AB does not necessarily equal BA.

1. Matrix division is undefined.
2. An identity matrix, I, is a square matrix in which the elements on the main diagonal have values of 1 and all others have values of zero.
3. Let A be a square matrix. Then the inverse of A, represented by A-1, is defined as the matrix which when multiplied by A yields an identity matrix. Thus, we see AA-1 = I. If B is the inverse of A, then A is the inverse of B and BA = I = AB.
4. A matrix which has no inverse is said to be singular. The Determinate = 0.
5. When a matrix A is multiplied by an identity matrix, the result is A;

IA =A.

**Some Matrix Operations**

The matrix operations demonstrate some of the topics reviewed above using EXCEL.

1. Enter the text and values shown in Al:G3 of Figure Use the *Merge and Center* tool to centre the text over two columns.
2. Enter the values in A4:E5.
3. We now find the elements of C such that A + B= C. In G4 enter the formula =A4+D4. Copy this to G4:H5.
4. Enter the text row 7 and centre each across two columns. To get superscripts, select the text (such as - 1) and use the command Format|Cells and put a check mark in the *Superscript* box on the Font dialog box.
5. Enter the values in A8:B9. These are the elements of matrix D*.*
6. To compute the inverse of *D,* select the range D8:E9. Enter the formula =MINVERSE(A8:B9) and press **Ctrl+Shift+Enter.**
7. To show that **DD**-1 = I*,* select G8:H9. Enter the formula

=MMULT(A8:B9, D8:E9) and press **Ctrl+Shift+Enter** .

You may wish to use the Formula Palette: type = MMUL T, press **Ctrl** +A. Do not click the OK button on the Formula Palette, use **Ctrl+Shift+Enter**.

Note that the main diagonal elements have values of 1. We expected the off-diagonal elements to have values of zero but in H8 we have -2.8E-17. Because Microsoft Excel uses a precision lE-16 in computing matrix functions) we shall accept this value as zero. If you replace the values in the first row by 1 and 2 and in the second row by 2 and 5, the off-diagonal elements compute to identically zero.

1. The formula =MDETERM(A8: B9) in A12 computes the determinant of the square matrix D.No inverse matrix exists for a matrix with a zero determinant. The formula in B12 is:

 =IF(A12=0,"Singular","Non-singular").