EZMAT

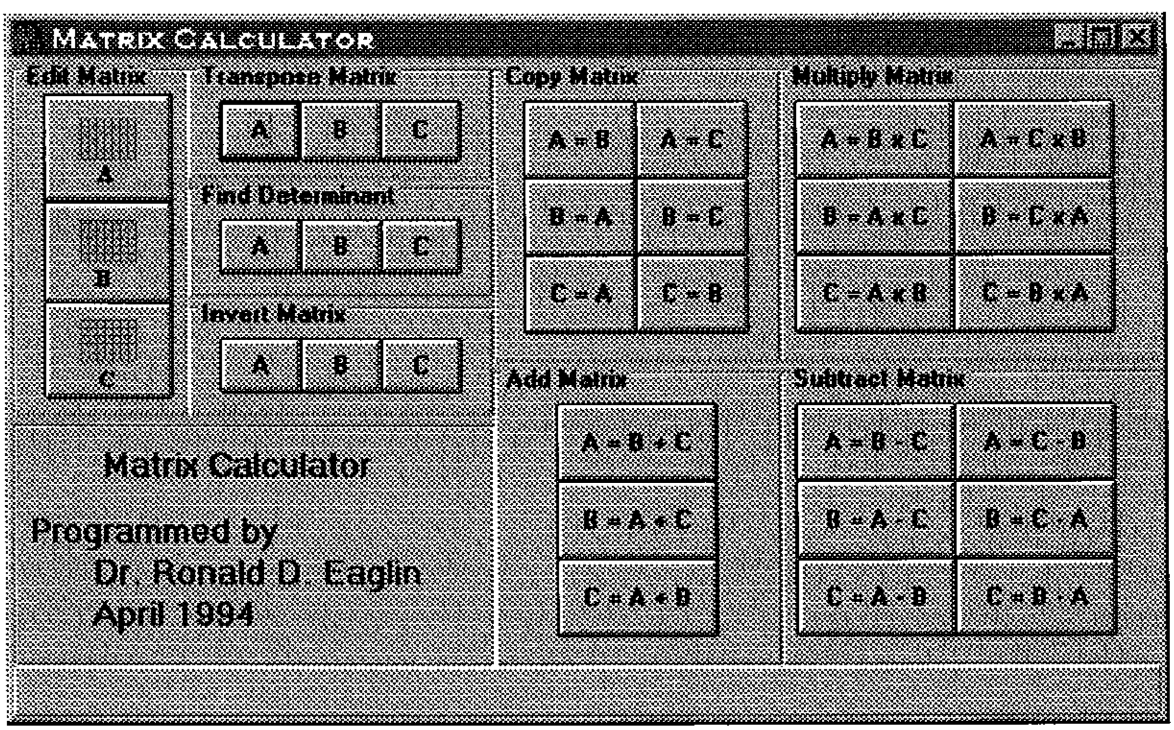
EZ Matrix Calculator

Introduction

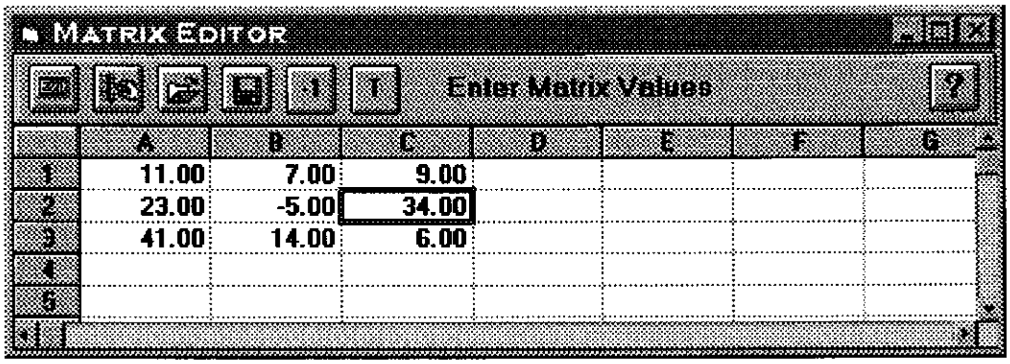
The matrix calculator is designed to simplify many of the operations which can be performed on matrices. The interface is designed to make these operations as simple as possible.

Using the Matrix Calculator

The matrix calculator allows for the storage of up to three matrices in memory at once. These three matrices are stored as variables **A**, **B**, and **C**. To edit any of these matrices, click on the **Edit Matrix** button for the matrix to be edited.



Matrix numbers can be directly entered into the **Matrix Editor** spreadsheet.



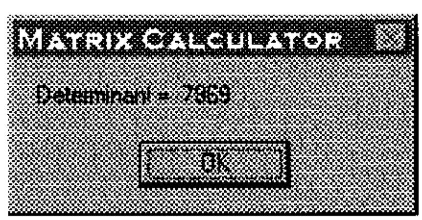
From the **Matrix Editor**,

the matrix can be inverted by clicking the invert matrix button 

or transposed by clicking the transpose button .

Click the red **Exit** button when you are done editing the matrix. The matrix will remain in memory.

After closing the matrix, the determinant can be calculated by clicking the **Find Determinant** button for that matrix. The determinant will be displayed in a dialog window.



Solving Simultaneous Equations

The matrix calculator can be used to solve simultaneous equations. This will be illustrated by an example.

**** Simultaneous Equation Example Problem ****

Solve the following set of simultaneous equations:

$$12x_1 + 54x_2 + 13x_3 = 27$$
$$9x_1 - 18x_2 + 7x_3 = 14$$
$$11x_1 + 52x_2 + 18x_3 = 72$$

The information can be arranged in the form:

$$\mathbf{A} \times \mathbf{X} = \mathbf{B}$$

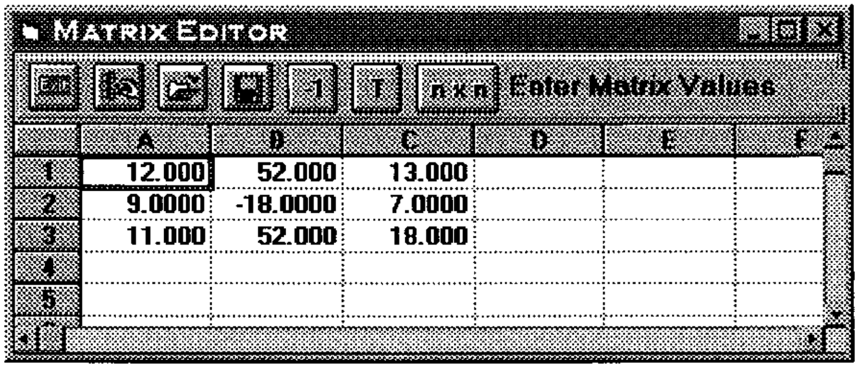
or in matrix format:

$$\begin{bmatrix} 12 & 54 & 13 \\ 9 & -18 & 7 \\ 11 & 52 & 18 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 27 \\ 14 \\ 72 \end{bmatrix}$$

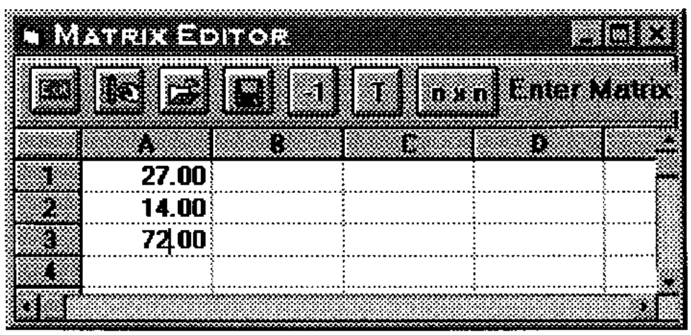
The original matrix form of the equation can be solved for the matrix **X** by multiplying both the left and right sides by the invert of matrix **A**.

$$\mathbf{X} = \mathbf{A}^{-1} \times \mathbf{B}$$

To solve using the matrix calculator enter the following as matrix **A**:

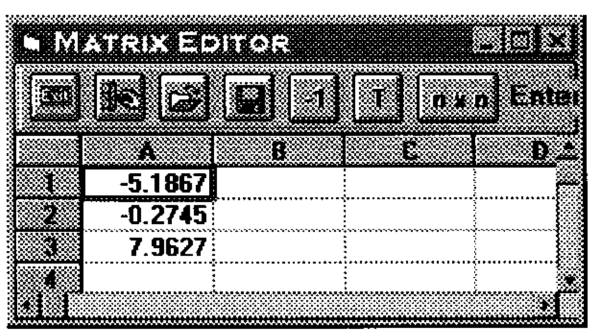


and the following as matrix **B**:



Next, take the inverse of matrix **A** (click the **Invert Matrix A** button) and then multiply the inverse by matrix **B** clicking the **C = A x B** button.

The results will be stored in matrix **C**.



or $\mathbf{x}_1 = -5.1867$, $\mathbf{x}_2 = -0.2745$, $\mathbf{x}_3 = 7.9627$

**** End of Simultaneous Equation Example Problem ****

Finding a Unit Hydrograph

The EZMAT calculator can be used to derive a unit hydrograph from rainfall excess and flow data. The equation for a unit hydrograph (U) in terms of excess (R) and runoff (Q) is:

$$\mathbf{U} = (\mathbf{R}^T \text{ x } \mathbf{R})^{-1}\, \mathbf{R}^T \text{ x } \mathbf{Q}$$

This multiplication can be easily performed with the matrix calculator. A special button has been added to perform the $\mathbf{R}^T$ x $\mathbf{R}$ multiplication.

This button is 

.

By entering the excess matrix and clicking this button and then clicking the invert button, the $(\mathbf{R}^T \text{ x } \mathbf{R})^{-1}$ portion of the equation can be solved. When entering the excess matrix it must be entered in the format:

$$\begin{matrix} R_1 & 0 & 0 \\ R_2 & R_1 & 0 \\ 0 & R_2 & R_1 \\ 0 & 0 & R_2 \end{matrix}$$

The total number of rows of the excess matrix should be equal to the number of values in the runoff matrix. The number of columns can be determined by adding columns until the final value of R_n is the last row.

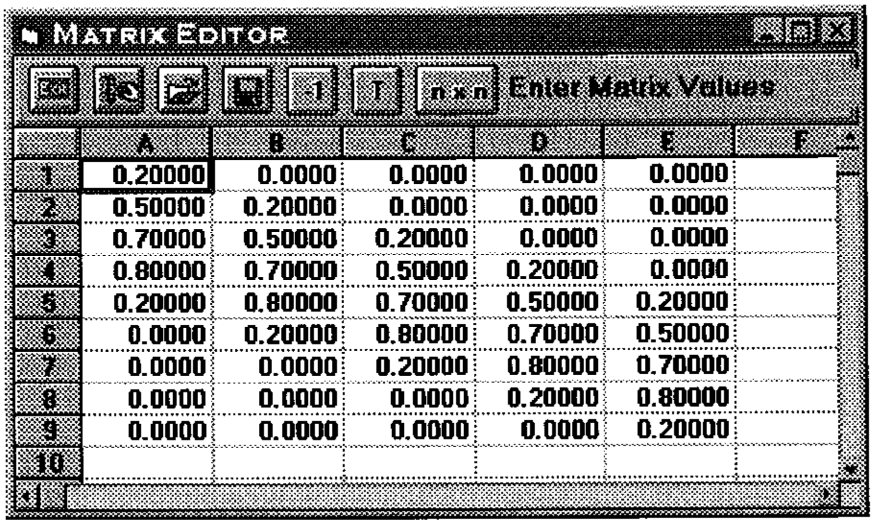
**** Example of Finding a Unit Hydrograph ****

The following rainfall excess and flow data are collected:

Rainfall Excess	Flow
0.2	0.02
0.5	0.13
0.7	0.33
0.8	0.54
0.2	0.635
0.0	0.45
0.0	0.215
0.0	0.07
0.0	0.01

Using the **Matrix Editor**:

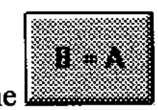
- enter the flow data in Columns A, B, C, D, and E as shown in **Matrix A** below:



	A	B	C	D	E	F
1	0.20000	0.0000	0.0000	0.0000	0.0000	
2	0.50000	0.20000	0.0000	0.0000	0.0000	
3	0.70000	0.50000	0.20000	0.0000	0.0000	
4	0.80000	0.70000	0.50000	0.20000	0.0000	
5	0.20000	0.80000	0.70000	0.50000	0.20000	
6	0.0000	0.20000	0.80000	0.70000	0.50000	
7	0.0000	0.0000	0.20000	0.80000	0.70000	
8	0.0000	0.0000	0.0000	0.20000	0.80000	
9	0.0000	0.0000	0.0000	0.0000	0.20000	
10						

Click the red **Exit** button to go back to the main **Matrix Calculator** window.

In the **Matrix Calculator** window:

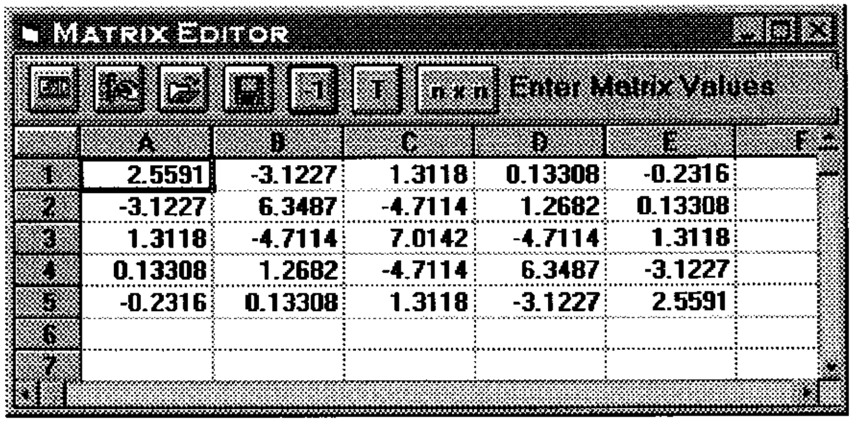
- first copy the Matrix **B** into **A** by clicking the  button
- then open Matrix **A** by clicking the A button in **Edit Matrix**.

In the **Matrix Editor** window:

- click the  button
- then click the  button.

Once these two buttons are clicked the original matrix will be replaced with the matrix $(\mathbf{R}^T \times \mathbf{R})^{-1}$.

The replaced matrix $(\mathbf{R}^T \times \mathbf{R})^{-1}$ becomes the current Matrix **A** as shown below:

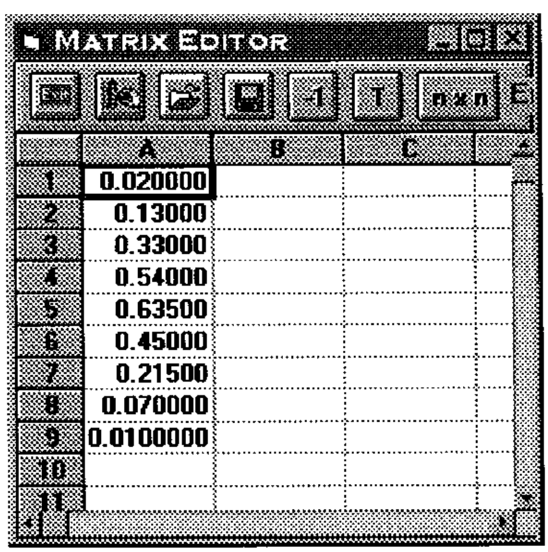


	A	B	C	D	E	F
1	2.5591	-3.1227	1.3118	0.13308	-0.2316	
2	-3.1227	6.3487	-4.7114	1.2682	0.13308	
3	1.3118	-4.7114	7.0142	-4.7114	1.3118	
4	0.13308	1.2682	-4.7114	6.3487	-3.1227	
5	-0.2316	0.13308	1.3118	-3.1227	2.5591	
6						
7						

Click the red **Exit** button to return to the main **Matrix Calculator** window.

In the **Matrix Calculator** window:

- Click the **Transpose B** button to take the transpose of Matrix **B**.
- Click the **C = A x B** button and the results $(\mathbf{R}^T \times \mathbf{R})^{-1} \mathbf{R}^T$ will be placed in Matrix **C**.
- Open Matrix **A** and clear the data by pushing the button. This will clear the matrix.
- Enter the Flow Data in the **Matrix Editor** window:



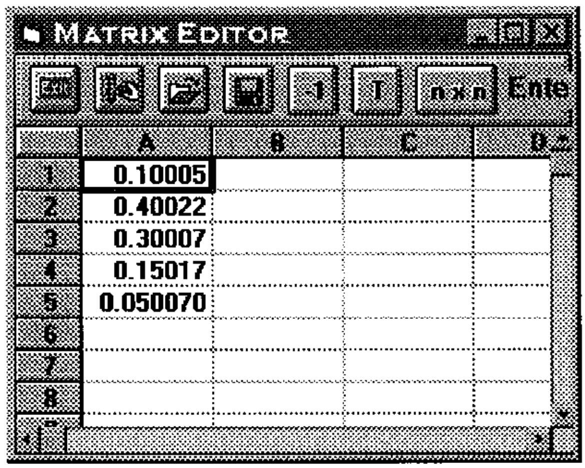
	A	B	C
1	0.020000		
2	0.13000		
3	0.33000		
4	0.54000		
5	0.63500		
6	0.45000		
7	0.21500		
8	0.070000		
9	0.0100000		
10			
11			

For the final step:

- Click the red **Exit** button to exit the Matrix Editor for Matrix **A**

In the Matrix Calculator window:

- The final mutliplication will be **B = C x A**.
- The final results will be in Matrix **B**.



Interpreting the results stored in matrix B, the unit hydrograph is 0.1, 0.4, 0.3, 0.15, 0.05.

**** End of Example of Finding a Unit Hydrograph ****

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