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Celan N. Kostem
AN INTRODUCTORY GUIDE
TO
QUATTRO
THE PROFESSIONAL SPREADSHEET
(Second Edition)

by

Celal N. Kostem

Fritz Engineering Laboratory
Department of Civil Engineering
Lehigh University
Bethlehem, Pennsylvania

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1. INTRODUCTION TO SPREADSHEETS

1.1 What is a Spreadsheet?
The spreadsheet is software which contains a "grid" for entering, viewing, and editing data. All spreadsheets also have capabilities to manipulate the entered data by using standard mathematical and statistical "functions."

The "grid" referred to above can be visualized as an "electronic ledger," as is usually the case with individuals who use spreadsheets for financial applications. Each entry of this ledger can be subjected to a wide variety of operations. The spreadsheet can also be visualized as an array or a matrix, in which each entry corresponds to an element of the array or matrix. Each and every element of this array is referred to as a cell. The location of a cell is defined by its column and row number.

The first column is marked column-"A," the second column as column-"B," etc. In QUATTRO one can have up to 256 columns. After exhausting the letters of the alphabet, the column numbering continues as "AA," "AB," etc. all the way to column "IV".

The rows are numbered in numeric sequence, starting with 1. QUATTRO can handle up to 8192 rows. The first cell's address is "A1," which is located at the upper left hand corner of this large "array." For example, the address of the cell at the 4th row and 3rd column is "C4."

In using a spreadsheet program the user will populate the cells, i.e. enter data, and then apply all required mathematical and statistical operations to a block(s) of cells.

*****************************************************************
Most of the figures included in this guide are copied from Getting Started with QUATTRO and QUATTRO User's Guide published by Borland International.
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1.2 A Historical Perspective
The first spreadsheet program marketed was called VISICALC, which was capable of handling 254 rows and 63 columns. The original developers had "financial computations" in mind. However, the concept of a spreadsheet was attractive to engineers and scientists. Thus, today, spreadsheet packages are used for a very wide variety of applications in almost every profession.

The best selling microcomputer software, not only for spreadsheets, but for any application software, is LOTUS 1-2-3. LOTUS 1-2-3 set de facto industry standards for the development of all spreadsheet software. Currently, Version 2.XX of LOTUS 1-2-3 is widely used. It is expected that the next version, i.e. Version 3.00, will be released in the near future with major enhancements over Version 2.XX.

1.3 Two vs. Three Dimensional Spreadsheets
LOTUS 1-2-3 and QUATTRO are two dimensional spreadsheets. In other words, they have one "flat array," where by specifying the row and column number one can identify the location of the "cell." There are also three dimensional spreadsheets. These spreadsheets contain a number of two dimensioned arrays. In addition to row and column number, one needs to identify the "page number" as well. A typical example of this type of software is INTECALC, for which Lehigh University has a site license. It is expected that the next version of LOTUS 1-2-3 will also be a three dimensional spreadsheet.

Even though LOTUS 1-2-3 is the most widely used spreadsheet software, there still exists a number of other packages which can do most of the work of LOTUS 1-2-3. In some cases, some of the "options" of these packages are "better" than those of LOTUS 1-2-3. A typical example of this is QUATTRO. QUATTRO has almost all of the capabilities of the current version of LOTUS 1-2-3, plus far superior "graphics." Besides, Lehigh University has a site License from Borland International, the developer of QUATTRO, for various Borland products, including QUATTRO.
Any previous user of LOTUS 1-2-3 will find the mastery of the use of QUATTRO quite simple. Also, any first time users of a spreadsheet software will find that once they are sufficiently familiar with QUATTRO, they will be able to use LOTUS 1-2-3 without any problems.

1.4 What is a BLOCK?
In a spreadsheet a cell corresponds to one location defined by its row and column number. However, in most computations and operations we need to identify a region containing a number of cells. Such a region is called a block. For example, the upper left hand corner of a block may have cell "C3," while the upper right hand corner of the block may contain cell "E3." The lower left and lower right corners of the block may contain elements "C5" and "E5," respectively. Once this block is marked by using the appropriate cursor keys, i.e., the arrow keys, then the color and/or shading of the block on the monitor screen will be different. In this case, the block will contain cells C3, D3, E3, C4, D4, E4, C5, D5, and E5; 9 elements are included in this block.

1.5 Graphics
A spreadsheet containing a very limited amount of information can be easily studied by "anybody(?)". However, if the information contained is more than trivial, and/or, especially, if the information contained in the spreadsheet is to be included in a report or presented at a meeting, then the use of graphics options of the spreadsheet is essential. Almost all spreadsheet software have the capability to draw bar, stacked bar, x-y plots, pie-charts, etc. The graphics options of the program will employ the data contained in the spreadsheet in the generation of the graphics. The graphs are displayed on the monitor screen. Hardcopy of these graphs can also be obtained.

1.6 Database Management
A database is an organized collection of data/information, which permits the manipulation of the data. For example, a class list of a multi-section course can contain the names, social security numbers and the university I.D. numbers of the students. In addition, section number and section instructor's name can be in-
cluded. As the semester progresses, the grades for various examinations, assignments, etc. can be entered. The course leader may very well wish to develop class lists based on section assignment, based on grades, or some slightly exotic items like the list of those who missed the quizzes. In addition, one can develop a list of students whose course grade is above, for example, 75%. These activities are all related to database management.

It is "claimed" that all spreadsheet programs, including QUATTRO, have database management capabilities. However, as the user gets more demanding in the manipulation of data, then the use of dedicated database management software is recommended, such as dBASEIV, RBASE:5000, PARADOX, etc. Most of these database management software accept the raw data files generated by most of the spreadsheet software, e.g., QUATTRO, LOTUS 1-2-3. However, if the database management activities are limited in scope, then the use of QUATTRO is sufficient for database management purposes.
2. HOW TO USE QUATTRO

The original QUATTRO documentation consists of three "guides," Getting Started with QUATTRO, User's Guide, and Reference Guide. It is nice to know the contents of these guides, however, the guides have a total thickness of about 2 inches. Without going through these guides and only studying the contents of this document one can start using QUATTRO. In addition, QUATTRO has extensive "HELP" capabilities which will be described later in this guide. Prior to going to the extensive printed manuals, guides, and textbooks, the users are strongly advised to use the HELP facilities of the software.

QUATTRO can be used with a microcomputer with floppy drives or with hard disk. Since the access speed to the files on floppy diskettes is slow, as compared to hard disk systems, the use of microcomputers with hard disks is strongly suggested.

Almost all public microcomputer sites of the Lehigh University Computing Center have Local Area Networks (LAN). Most of the file servers at these sites have QUATTRO on the hard disk(s). After booting the microcomputer with the LAN diskette, make appropriate changes in your default drives and directories. Issue the command CD QUATTRO, to change to the QUATTRO subdirectory. Then issue the command Q. This will activate the software. Your monitor screen will look like Fig. 1. You are now ready to use the software.
Fig. 1: A Blank QUATTRO Spreadsheet
3. MASTER MENU

3.1 Definitions
A close inspection of the display on your monitor is needed. This will permit the definition of some of the key terms. These terms are shown in Fig. 2.

Fig. 2: The QUATTRO Spreadsheet

Row and column identification numbers and letters are displayed as shown in the figure. Once you "activate" QUATTRO, you will find that the "area" corresponding to CELL A1 is displayed in a different color and/or shade. On the second line from the bottom the descriptor line will show the address of the cell where the "pointer," i.e., the highlighted cell, is located. The contents of this cell, if any, will also be displayed. At the top of the screen you will see a blank line. All entries you make through the keyboard and cursor keys will be displayed on this line.

3.2 Help and Escape
QUATTRO has extensive "help" capabilities. For example, when you are at the screen shown in Fig. 1, you can press "F1" key. Your screen display will look like Fig. 3.
You can move the "highlighted" area from one subject to another via cursor control keys, i.e. the keys with arrow signs. When you reach the subject matter about which you want information simply press the RETURN key. You will get a summary of the subject matter. This help screen is not limited to the display shown on Fig. 3. The "help facility" of QUATTRO is "context sensitive." Depending upon which command you issue or the activity you undertake, by pressing the "F1" key you will get the help screen associated with that particular operation. This eliminates the constant need to refer to the manuals.

To get out of the "help screen" and to return to the original spreadsheet screen, you need to press the ESCAPE key. The ESCAPE key can be considered as a "universal abort key." By pressing this key, you will go back to the previous command level. Another important use of this key will be to abort an improper command. If the command you issued is incorrect, then the program will indicate the error. To get out of this error and to return to the "previous mode" or previous command level, simply press the Escape key. Also note the use of the Escape key in the following section on the use of menus.
3.2 Menus and Sub-Menus
One of the most attractive features of QUATTRO is its menu structure. Once the basic spreadsheet is displayed you can enter a "slash," i.e. "/". Upon issuing this command your screen will look like Fig. 4.

![Menu Diagram]

Fig. 4: The QUATTRO Main Menu

By using the "up arrow" or "down arrow" keys you can move the "highlighting" from one menu item to another. If you press the RETURN key, then the "command" corresponding to the highlighted command will be issued. Instead of moving the highlighted area by arrows, you can also issue the same command by entering the first letter of the command via the keyboard.

Most of the entries of the master menu have sub-menus. You can practice identifying the contents of the sub-menus by a little trial and error. Any detailed information that might be provided herein is outside the scope of this Guide; this information can be found in QUATTRO's official "Guides."

3.3 Main Menu Entries
In order to familiarize the user with the capabilities of each entry in the main menu level, only a brief description will be provided.
3.3.1 BLOCK
The BLOCK menu contains subcommands that affect a block of cells you define within the spreadsheet. This block may be as small as one cell. It may be a column or a row of specified length. The "shape" of the block must be rectangular, for blocks containing more than one row and one column.

The sub-menu corresponding to BLOCK is shown in Fig. 5.

---Block---
Copy
Move
Erase
Display Format
Label Align
Fill
Search/Replace
Reformat
Advanced

Fig. 5: The Block Menu

Through the available commands at the sub-menu level one can:

* Copy a block from one part of the spreadsheet to another.
* Move a block from one location to another.
* Erase the contents of a block.
* Change the display format of a block.
* Change the alignment of labels.
* Automatically generate a series of value entries on specified cells.
* Search for specific data and replace it with new data.
* (Reformat and Advanced commands are beyond the scope of this Guide.)
3.3.2 COLUMN
The sub-menu associated with the COLUMN is shown in Fig. 6.

![Column Menu](image)

Fig. 6: The Column Menu
Brief descriptions associated with the entries in Fig. 6 are:

* Insert blank column(s) to the left side of the highlighted cell.

* Delete existing column(s) in the spreadsheet. Note that this deletion will cause the loss of data contained in these columns!

* Change the width of a given column.

* Temporarily remove columns from display without losing the contents.

3.3.3 ROW
The operations associated with this sub-menu are similar to those for COLUMN, except the operations will be carried out on row(s).

3.3.4 ERASE
Erase command clears the spreadsheet. If this command is issued, without first saving the contents of the spreadsheet (See FILE below), you may lose valuable information and hours and hours of investment! Be careful!

3.3.5 FILE
The sub-menu for FILE is shown in Fig. 7.
Some of the operations that can be carried out under the FILE menu are:

* Retrieve an existing spreadsheet file.
* Save the current spreadsheet on a hard disk or floppy.
* Combine two spreadsheets into one file.
* Load a file created by another spreadsheet software. (Note: You can import LOTUS 1-2-3 files.)
* Push to MS-DOS operating system. (You can return to QUATTRO by typing and entering EXIT at MS-DOS.)
* Etc.

3.3.6 GRAPH
This will be discussed separately in Chapter-5.

3.3.7 MACRO
A macro is a series of commands stored within the current spreadsheet. It can be considered as a "program" coded in QUATTRO understandable commands. This macro can be executed by issuing "special commands." Due to the advanced nature of this subject, it will not be covered in this Guide.
3.3.8 PRINT
The contents of the PRINT sub-menu are shown in Fig. 8.

![Print Menu Diagram]

Fig. 8: The Print Menu

Print command is used to print the spreadsheet.

3.3.9 LAYOUT
The sub-menu contains commands to change the "look" of the spreadsheet.

3.3.10 DEFAULT
The menu contains instructions to change the "default settings" of QUATTRO.

3.3.11 ADVANCED
The menu contains commands used in "database management," statistical analyses, inversion and multiplication of matrices.

3.3.12 QUIT
This command gets you out of QUATTRO. You will return to MS-DOS. Prior to issuing this command do not forget to save your spreadsheet. The contents of the spreadsheet will be irrecoverably lost!
4. DEMONSTRATION PROBLEMS

4.1 Problem-1: Expense Account
This problem demonstrates the applications of the software on "financial computations." This problem is taken from User's Guide to QUATTRO. Fig. 9 contains the basic information that will be entered for this spreadsheet. Enter this information in the sequence described below.

![Expense Report Spreadsheet](image.png)

**Fig. 9: The Example Spreadsheet**

4.1.1 Entering the Headings
1. Enter EXPENSE REPORT FOR ALLISON SPRINGS in cell B3.
4. Enter DATE in cell B6.
   (" character will center the label in the cell.)
5. Enter LOCATION, TRANSPORT, HOTEL, ENTERTAIN, and MEALS in cells C6, D6, E6, F6, and G6, respectively.
6. Enter SUNDAY, MONDAY, TUESDAY, WEDNESDAY, THURSDAY, FRIDAY, and SATURDAY in cells A7, A8, A9, A10, A11, A12, and A13, respectively.
   (Without " ~ " the labels will be left-justified.)

7. Enter TOTAL in cell A15.

4.1.2 Saving and Retrieving the Spreadsheets
With the above information you have entered the captions of the table. Before going any further it is a good time to practice saving files, erasing the spreadsheet, and retrieving a file. Do the steps described below:

1. Press slash (/) key. The main menu will appear. Move the highlighted area by using cursor keys to File command. Press the RETURN key.

2. FILE sub-menu will appear. Using the cursor keys move the highlight to Save. Press the RETURN key. A list of spreadsheet files in the default directory will be displayed (At LUCC's microcomputer laboratories with LAN, the default drive is A:). QUATTRO will also prompt you for a file name, under which your current spreadsheet will be saved. Give a unique name. This name should be different from any of the already existing spreadsheet files. If the given name is the same as an existing spreadsheet file's name, then an attempt is made to copy the contents of the file on workspace to the hard disk or diskette on the existing file. If that is the case, software will indicate the existence of such a file, and will prompt you whether to discontinue the operation, or to continue. The continuation of the operation is usually done to update the contents of a given file during a long session behind the microcomputer. In the case of potential temporary loss of power, the data stored on the computer's workspace will not be lost. It is a good habit if you save your spreadsheet every 10-15 minutes.

3. To be on the safe side, press the ESCAPE key a couple of times, until you are back at your original spreadsheet. Issue slash, FILE, SAVE commands. Check if the file you
saved is listed as one of the spreadsheet files in your default directory. If it is, then issue a couple of ESCAPE commands, until you are back at the original spreadsheet.

5. Press the slash (/) key, and then issue the ERASE command. Your spreadsheet will be erased.

6. Press the slash (/) key, then issue FILE command, to be followed by RETRIEVE. The spreadsheet files in your default directory will be displayed. By moving the highlighted cell identify the file you just saved. Press the RETURN key. The file you saved will be loaded.

4.1.3 Changing Column Widths
You can practice changing the "column widths" by the following steps. As you can see, the full caption of DAY OF WEEK is not displayed in it's entirety. We need to increase the column width for column-A.

1. Press slash (/) to bring in the main menu. Move the highlighted area down to COLUMN. Press the RETURN key.

2. Move the highlight to Width, and press the RETURN key.

3. Move the highlighted cell (pointer) to any cell in Column-A. The software will indicate that Column-A is nine spaces wide. This is not wide enough to display the full DAY OF WEEK caption. Change the width to 13 columns. Press the RETURN key.

4.1.4 Entering Numeric Data as Labels
Next we will enter the "dates" displayed in column-B, (cells B7 through B13.) We want to treat the dates as "labels." If we enter the dates as shown, QUATTRO will assume that you are performing an arithmetic operation. Thus, before keying in each date entry put a single apostrophe, ('). Thus the first date should be entered as '06/21/1987. However, on the screen the date will be displayed without the apostrophe.
4.1.5 Copying
1. Enter SAN DIEGO to cell C7.

2. Cells C8 through C12 will have SAN DIEGO as well. Rather then repeating the entry, we will copy the contents of cell C7 to cells C8 through C12.

3. Bring up the main menu. Issue BLOCK command. At the Block sub-menu, issue Copy command.

4. In copying you need to identify the source to be copied from. Using the cursor keys move the highlight to cell C7. Press the RETURN key.

5. Move the highlight to cell C8. Press the "period" key. By doing this you have "anchored" the highlighted block. By using the cursor key, pull down the highlighting, to include cell C12. Watch the top of the screen. As you move the highlighted area, the address range indicated will change. When the highlighted area covers from cell C8 through cell C12, press the RETURN key. The contents of cell C8 will be copied to cells C9 through C12.

6. Enter SAN JOSE to cell C13.

7. Enter the numerical values to columns, without using the dollar sign ($), to cells D7 through D13, E7 through E13, F7 through F13, and G7 through G13.

8. Since you have entered quite a bit of information, it is a good idea to save the contents of the spreadsheet. Issue FILE and SAVE commands. REPLACE the existing file on your default drive with the spreadsheet you are operating.

4.1.6 Formulas
You need to find the total amount spent for TRANSPORT. Move the highlight to cell D15. Enter the following formula

\[ +D7+D8+D9+D10+D11+D12+D13 \]
The above formula will add the contents of the indicated cells. It should be noted that by putting a plus sign (+) before the expression you are informing QUATTRO that what follows is a formula, and not a label. If we have many entries to be added, the above formula will be too laborious.

The summations corresponding to Columns E, F, and G can be done more expeditiously and professionally as follows.

1. Move the highlight to cell E15.

2. Enter the following expression @SUM(

3. By using the arrow keys move the highlight to cell E7.

4. Press the period key (.); you have anchored the block to be defined.

5. By using the arrow keys enlarge the highlighted block to include cell E13. Look at the top of the screen. Your "formula" should read: @SUM(E7..E13

6. Enter the close parenthesis sign, ()). The formula at the top should read @SUM(E7..E13).

7. Press the RETURN key. The numerical value of your sum will be displayed in cell E15.

As indicated earlier, QUATTRO has a number of built-in functions. One of them is the summation function we just used. All formulas start with an "at" sign, (@).

8. Copy the contents, i.e. the formula, in cell E15, to cells F15 and G15. The spread sheet will display the numerical values of the summation for each column. However, if you move the highlighted cells from E15 to F15, etc, watch the second line from the bottom. The formulas will be displayed.

9. Inspect the range of formulas at cell E15 vs. F15. The range of the formula used in cell E15 is over column-E, whereas the range of the formula at cell F15 is over column-F. In copying a formula from one cell to another,
the software automatically makes the necessary adjustments in the "address range." This characteristic of the spreadsheet software makes the manipulation of the spreadsheets a less laborious one.

4.1.7 HOME, TAB, SHIFT-TAB, PAGE-UP, PAGE-DOWN
Regardless of where the highlighted cell might be, if you press the HOME key, the pointer (the highlighted cell) will move to cell A1.

If the spreadsheet is wide, it will take a number of screens to display the contents. Note that with default column widths, you can display 8 columns and 20 rows in "one screen." If you press the TAB key, the next screen will be brought up. Try this a couple of times, and watch the column numbers at the top of the screen. Note that the row numbers do not change. You can press the HOME key to go back to your original screen.

Again press the TAB key a number of times. This time instead of pressing the HOME key, hold the SHIFT key down, and press the TAB key. For each of these actions you will be moving your screen display towards Column-A.

If the spreadsheet is long, i.e. many rows, press the PAGE-DOWN key. You will keep the column numbers the same, but you will be displaying new higher numbered rows. With the PAGE-UP key you will be doing just the opposite. By pressing HOME key you will move to cell A1.

We need to create a new column to display the total expenses day-by-day.

1. Move to cell H6, and enter ^TOTAL.

2. Move to cell H7, and enter the formula @SUM(D7..G7). Use the steps described in Section-4.1.6 of this Guide.

3. Copy the formula to cells H8, H9, H10, H11, H12, and H13 by using the approach described in Section 4.1.5 of this Guide.
4. Go to cell H15. Enter the formula @SUM(H7..H13). Use the steps described earlier in this subsection.

5. The amount shown will correspond to the total expenses. Actually, in cell H15 you will see a series of asterisks. This indicates that the column width (i.e. Column-H) is too narrow to display the results. By using the technique described in Section 4.1.3, increase the width of this column.

4.1.8 Changing the Format
In the spreadsheet all entries for the expenses are displayed as integers (if the number is a whole number or zero) or as real numbers (if the number is,  

![Display Format Menu](image)

Fig. 10: The Display Format Menu for example, 27.55). If we wish to change the format used for these numbers we need to go to the Default menu. (Use slash, then activate the DEFAULT command.) At the sub-menu select FORMATS. At the sub-menu of FORMATS, activate DISPLAY. Display sub-menu is shown in Fig. 10. Choose the CURRENCY option. This is will display two digits after the decimal point. By this selection, a number like 1234.56 will be displayed as $1,234.56.

4.1.9 Sprucing-up
To give a more professional look to your spread sheet, you may wish to put a horizontal line from cell D14 to H14. An expeditious approach for this operation will be to go to cell D14,
and enter \- (backslash followed by a minus sign). Press the return key. Cell D14 will contain a "horizontal" line. By using the procedures used in Section 4.1.5, copy the contents of this cell to cells E14, F14, G14, and H14.

4.1.10 Some Experimentation
By now you should have a finished spreadsheet. In this section we will demonstrate the modifications one can make, and their ramifications.

1. Go to cell C7, enter BETHLEHEM. You will see that all SAN DIEGO labels listed below will be changed to BETHLEHEM. This action took place because the contents of cell C7 were copied to generate cells C8 through C12.

2. Change the contents of cell C7 back to SAN DIEGO.

3. Go to cell D7. Change the amount from 89. to 289. You will see that the total at the bottom of this column, the total of Column-H, as well as the grand total in cell G15, are automatically changed.

4. Change the amount back to 89.

The above experimentation shows a built-in danger of arbitrarily modifying spreadsheets. For example, the contents of cell C7 were copied to the cells below. You may wish to change only one entry, whereas you changed all SAN DIEGO entries. Thus, prior to making any changes, it is absolutely essential that you know the extent of modification, or damage, you will be making by a careless change.

The above experimentation also shows the great ease with which you can make the necessary corrections to the entries. If the mode of operation of the spreadsheet is properly set, then upon the modification of any one cell, all necessary re-calculations are automatically performed.
4.2 Problem-2: An Engineering Application

In Fig. 10 a "simple beam" is shown. When this beam is subjected to uniformly distributed loading, as shown, the beam will deflect vertically. The vertical deflection of this beam can be computed using the following formula:

\[ y = \frac{Qx}{24EI} \left( L^3 - 2Lx^2 + x^3 \right) \]

In the above formula the meaning of the terms used are:

- \( E \) = Modulus of elasticity of beam material = 30,000,000 pounds per in\(^2\)
- \( L \) = Span length = 120 inches
- \( Q \) = Magnitude of the uniformly distributed load = 10 pounds/inch
- \( I \) = Moment of inertia of the beam cross section = 150 in\(^4\)

In Fig. 11, the local coordinate system is also indicated. "x" is the distance from the "origin," measured in inches. Vertical deflections are also measured in inches, and are in the direction of the positive "y-axis."

By using QUATTRO, deflections of the beam will be computed at locations \( x=0, x=12, x=24, x=36, \ldots x=120 \). (i.e., the span length will be divided into 10 equal segments.)
4.2.1 The Spreadsheet Design

In cells A1, A2, A3, and A4 "titles" for "E=", "L=", "Q=", and "I=" will be entered, respectively. In cells B1 through B4, the numerical values of these constants will be entered, i.e., 30000000, 120, 10, and 150, respectively. In the beam deflection formula, there exists a constant "multiplier," which does not change its numerical value regardless of any changes in "x." Thus, as a title in cell A5 the title of "C=Q/(24*E*I)" will be entered. In cell B5 the "formula" for this constant in terms of cell address locations will be defined, i.e., +B3/(24*A1*B4).

Put titles of "X" and "Y" for A and B columns. These values will be placed at cells A7 and B7. The numerical values of "x," as defined earlier, and "y," using the formula, will be entered under the respective titles.

The above operations can be described as:

<table>
<thead>
<tr>
<th>Pointer at</th>
<th>Enter</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>E=</td>
</tr>
<tr>
<td>B1</td>
<td>30000000</td>
</tr>
<tr>
<td>A2</td>
<td>L=</td>
</tr>
<tr>
<td>B2</td>
<td>120</td>
</tr>
<tr>
<td>A3</td>
<td>Q=</td>
</tr>
<tr>
<td>B3</td>
<td>10</td>
</tr>
<tr>
<td>A4</td>
<td>I=</td>
</tr>
<tr>
<td>B4</td>
<td>150</td>
</tr>
<tr>
<td>A5</td>
<td>C=Q/(24<em>E</em>I)</td>
</tr>
</tbody>
</table>

At this step you will note that the "title" for "C=Q/(24*E*I)" is too long to be displayed using the default width of the cells; which is 9 spaces wide. Change the width to 15 spaces using the following steps, and continue entering the formula.

<table>
<thead>
<tr>
<th>Pointer at</th>
<th>Enter</th>
<th>(Comments)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A5</td>
<td>/</td>
<td>Brings up the master menu.</td>
</tr>
<tr>
<td>A5</td>
<td>C</td>
<td>Column option.</td>
</tr>
<tr>
<td>A5</td>
<td>W</td>
<td>Width definition option.</td>
</tr>
<tr>
<td>A5</td>
<td>15</td>
<td>New column width will be 15 spaces.</td>
</tr>
<tr>
<td>A7</td>
<td>^X</td>
<td>Centered title for x-values.</td>
</tr>
<tr>
<td>B7</td>
<td>^Y</td>
<td>Centered title for y-values.</td>
</tr>
</tbody>
</table>
4.2.2 Table Generation

The numerical values for "x," i.e., 0., 12., 24., etc., can be manually entered. However, this is a tedious operation and prone to error. This is especially the case if the number of data points to be entered get large. Thus, a new approach will be used: The Block Fill command, (in LOTUS 1-2-3 this is referred to as Data Fill Command.) The steps are described below.

<table>
<thead>
<tr>
<th>Pointer at</th>
<th>Enter</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A8</td>
<td>/</td>
<td>Brings up the master menu.</td>
</tr>
<tr>
<td>A8</td>
<td>B</td>
<td>Brings up the Block Submenu.</td>
</tr>
<tr>
<td>A8</td>
<td>F</td>
<td>Issues the &quot;fill&quot; command.</td>
</tr>
<tr>
<td>A8</td>
<td>.</td>
<td>Anchors the starting cell of the &quot;block&quot; to be defined.</td>
</tr>
<tr>
<td>A8 through A18</td>
<td>DOWN ARROW</td>
<td>Defines the block.</td>
</tr>
<tr>
<td>A18</td>
<td>ENTER</td>
<td>Defines the block.</td>
</tr>
<tr>
<td>A8</td>
<td>0 &lt;ENTER&gt;</td>
<td>Defines the starting value of &quot;x.&quot; Follow the instructions shown on the screen.</td>
</tr>
<tr>
<td>A8</td>
<td>12 &lt;ENTER&gt;</td>
<td>Defines the &quot;increment&quot; for &quot;x&quot;.</td>
</tr>
<tr>
<td>A8</td>
<td>120 &lt;ENTER&gt;</td>
<td>Defines the &quot;terminal&quot; value of &quot;x&quot;.</td>
</tr>
<tr>
<td>B8</td>
<td>$B$5<em>A8</em>($B$2<em>3-2</em>$B$2*A8^2+A8^3)</td>
<td>The above expression defines the formula for the vertical deflection.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(See below regarding the use of &quot;$&quot; sign.)</td>
</tr>
<tr>
<td>B8</td>
<td>/</td>
<td>Brings up the master menu.</td>
</tr>
<tr>
<td>B8</td>
<td>B</td>
<td>Brings up the Blocks Submenu.</td>
</tr>
<tr>
<td>B8</td>
<td>C &lt;ENTER&gt;</td>
<td>Issues the Copy command.</td>
</tr>
<tr>
<td>B8</td>
<td>.</td>
<td>Anchors the starting cell of the &quot;block&quot; to be defined.</td>
</tr>
<tr>
<td>B8 through B18</td>
<td>DOWN ARROW</td>
<td>Defines the block.</td>
</tr>
<tr>
<td>B18</td>
<td>&lt;ENTER&gt;</td>
<td>Defines the block.</td>
</tr>
</tbody>
</table>

In columns "A" and "B" the numerical values of "x" and "y" can be seen. At this stage it is a good idea to save the contents of the spreadsheet on your diskette or hard drive. Fig. 12 depicts the display you will see on the monitor.

25
4.2.3 Absolute vs. Relative Addresses

In the above relatively lengthy formula address location, i.e., cell A8 contains the value of "x." When this formula is copied to the cells below, the address locations, A9, A10, etc. are utilized. It is essential that correct values of "x" be used at different lines of the spreadsheet. Thus, as the formula is copied from one cell to another, the cell addresses are modified. These are referred to as relative address locations.

However, in the expression continuous references are made to the contents of cell B2, which contains the numerical value of "L," and cell B5, which contains the numerical value of the "constant." As the formula is copied from cell B8 to, for example, B9, the cell addresses referred to earlier will be B3 and B5. Such "copying" will lead to totally incorrect results. It is essential that references made to cells B2 and B5 should remain unchanged throughout the copying process. In order to make an "absolute" reference it is necessary to use "$" sign before the column and row number. That is, the reference made to
cell B2 should be expressed as $B2$. These are called absolute addresses. In the development of the spreadsheet if a reference is to be made to a cell location, and if the reference is always to be made to the same location, then the use of absolute addresses is necessary.

If the generated and copied formulas in the spreadsheet are to be displayed, they will look as shown in Fig. 13.

\[
\begin{align*}
E &= 30000000 \\
L &= 120 \\
Q &= 10 \\
I &= 150 \\
C &= \frac{Q}{(24E*I)} + \frac{B3}{(24B1*B4)}
\end{align*}
\]

Fig. 13: Beam Deflection Spreadsheet, with Formulas Displayed

4.2.4 Extension of the Spreadsheet
The above exercise was conducted for a beam simply supported at both ends, i.e., roller-pin supports. If the left support of this beam is a roller and the right support is encased in a rigid "wall," then the governing equation becomes:

\[
Q 
\begin{align*}
y &= \frac{Q}{48EI} \left( -3LX^3 + 2X^4 + Lt^3 X \right)
\end{align*}
\]

This type of beam configuration is referred to as "propped-cantilever beam." The above formula can be entered at cell C8 using the steps described earlier. The formula in cell C8 can then be copied to cells C9 through C18. The resulting spreadsheet is shown in Fig. 14.
E = 30,000,000
L = 120
Q = 10
I = 150
C = Q/(24*E*I) = 9.26E-11

\[
\begin{array}{ccc}
X & Y1 & Y2 \\
0 & 0 & 0 \\
12 & 0.001884 & 0.000933 \\
24 & 0.003564 & 0.00172 \\
36 & 0.004879 & 0.002258 \\
48 & 0.005714 & 0.002488 \\
60 & 0.006 & 0.0024 \\
72 & 0.005714 & 0.002028 \\
84 & 0.004879 & 0.001452 \\
96 & 0.003564 & 0.000799 \\
108 & 0.001884 & 0.000242 \\
120 & 0 & 0 \\
\end{array}
\]

Fig. 14: Propped Cantilever Beam Spreadsheet

4.11 EDIT
Quite often entries in one or more cells may be quite lengthy, especially in the case of formulas. Rather than re-entering the new contents of the cell, you should use the EDIT option. Move the highlight to the cell you want to edit. Press "F2" function key. The contents of the cell will be displayed at the top of the screen. By using arrow, insert, delete, backspace, etc. keys you can edit the contents of the cell. When you are finished, press the RETURN key.
5. GRAPHICS

5.1 GRAPH Sub-Menu
One of the strengths of QUATTRO is its ability to create a wide variety of graphs, customized by the user, using the data entered in the spreadsheet. In order to create a graph you need to issue the GRAPH command at the main menu. The graph sub-menu, as shown in Fig. 15, will appear. Some of the graphs you can generate are shown in Fig. 16.

![Graph Menu](image)

**Fig. 15: The Graph Menu**

The meaning of the commands appearing in the sub-menu is briefly described below:

* Graph Type: There are ten different "types" of graphs; you may select any one of them. The types of graphs that are available are shown in Fig. 17.

* X-Axis values: In graphs that use "x-y" axes, this will be the horizontal axis.

* Series Values: In a given typical "x-y" graph you can plot up to six "curves." The "y-value" for the first curve will be in Series-1, the second curve in Series-2, etc. The sub-menu for the "series values" is shown in Fig. 18.
Fig. 16: Different Graphs Plotting the Same Information
Fig. 17: The Graph Type Menu

Fig. 18: The Series Values Menu
* Titles: You can have a title and a subtitle for the graph. In addition, you will have titles for the "x and y" axes. Under the Font sub-menu you will have different options, as shown in Fig. 19. Figure 20 shows the display style of these fonts.

<table>
<thead>
<tr>
<th>Font</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Default</td>
</tr>
<tr>
<td>B.</td>
<td>Bold</td>
</tr>
<tr>
<td>C.</td>
<td>Triplex</td>
</tr>
<tr>
<td>D.</td>
<td>Sans Serif</td>
</tr>
<tr>
<td>E.</td>
<td>Small</td>
</tr>
<tr>
<td>F.</td>
<td>Simplex</td>
</tr>
<tr>
<td>G.</td>
<td>Triplex Script</td>
</tr>
<tr>
<td>H.</td>
<td>Script</td>
</tr>
<tr>
<td>I.</td>
<td>EuroStyle</td>
</tr>
<tr>
<td>J.</td>
<td>Complex</td>
</tr>
<tr>
<td>K.</td>
<td>Gothic</td>
</tr>
</tbody>
</table>

Fig. 19: The Fonts Menu

Default
Bold
Triplex
Sans Serif

Fig. 20: Eleven Available Type Fonts

Script
Eurostyle
Complex
Gothic

Triplex Script
* Customize: A number of options are available. They are essentially used to "enhance" the graphic presentation.
* Reset: Returns you to the previous "menu settings" of the graph.
* Name: Permits you to store the graph with your spreadsheet file with the name you will assign.
* Print: Issue this command to print your graph.
* View: Displays the current graph on the screen. This command should be frequently issued as you are modifying or enhancing the graph. To return to the graph menu press ESCAPE key.
* Quit: Returns you to the main menu of QUATTRO.

5.2 Exercise-1: Expense Account
In this exercise the total amount of money spent for transportation, hotel, entertainment, and meals will be plotted as a bar chart, as shown in Fig. 21. Issue the Graph command at your main menu. For the X-axis, identify the block consisting of cells D6, E6, F6, and G6. For the 1st series values identify the block containing D15, E15, F17, and G15. Without any enhancements, view the graph. If it is satisfactory, then experiment with enhancements of your choice.

Fig. 21: The Bar Graph of the Exercise Problem
Go back to the graph menu, and change the type of the chart to "Pie Chart." Again view the resulting chart.

5.3 Exercise-2: Beam Deflection Problem
In Section 4.2 of this document spreadsheets were generated to compute the vertical deflection of a simple span beam and a propped-cantilever beam. If the "x vs. y" plots can be developed, then the deflected shapes of the beams can be easily visualized. In order to produce a graph which contains these two deflected shapes issue the following set of commands, but first copy the original spreadsheet to your workspace:

<table>
<thead>
<tr>
<th>Pointer at</th>
<th>Enter</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A8</td>
<td>/</td>
<td>Brings up the master menu.</td>
</tr>
<tr>
<td>A8</td>
<td>G</td>
<td>Brings up the Graph Submenu.</td>
</tr>
<tr>
<td>Move the pointer to</td>
<td>GRAPH TYPE</td>
<td>Anchors the first cell of x-values to be</td>
</tr>
<tr>
<td>A8</td>
<td>&lt;ENTER&gt;</td>
<td>plotted.</td>
</tr>
<tr>
<td>Move the pointer to</td>
<td>XY &lt;ENTER&gt;</td>
<td>Defines the block containing the x-values.</td>
</tr>
<tr>
<td>A8</td>
<td>X-AXIS VALUES</td>
<td>Enters the x-values to the software.</td>
</tr>
<tr>
<td>Move the pointer to</td>
<td>&lt;ENTER&gt;</td>
<td>Anchors the block which will contain the</td>
</tr>
<tr>
<td>A8 through A18</td>
<td>DOWN ARROW</td>
<td>values of &quot;y&quot; for simple beam.</td>
</tr>
<tr>
<td>A18 through A18</td>
<td>DOWN ARROW</td>
<td>Defines the block.</td>
</tr>
<tr>
<td>Move the pointer to</td>
<td>SERIES VALUES</td>
<td>Anchors the block which will contain the</td>
</tr>
<tr>
<td>B8</td>
<td>&lt;ENTER&gt;</td>
<td>values of &quot;y&quot; for propped-cantilever beam.</td>
</tr>
<tr>
<td>Move the pointer to</td>
<td>1ST SERIES</td>
<td>Defines the block.</td>
</tr>
<tr>
<td>B8 through B18</td>
<td>DOWN ARROW</td>
<td>Defines the block.</td>
</tr>
<tr>
<td>B18</td>
<td>&lt;ENTER&gt;</td>
<td>Defines the block.</td>
</tr>
<tr>
<td>Move the pointer to</td>
<td>SERIES VALUES</td>
<td>Anchors the block which will contain the</td>
</tr>
<tr>
<td>C8</td>
<td>&lt;ENTER&gt;</td>
<td>values of &quot;y&quot; for propped-cantilever beam.</td>
</tr>
<tr>
<td>Move the pointer to</td>
<td>2ND SERIES</td>
<td>Defines the block.</td>
</tr>
<tr>
<td>C8 through C18</td>
<td>DOWN ARROW</td>
<td>Defines the block.</td>
</tr>
<tr>
<td>C18</td>
<td>&lt;ENTER&gt;</td>
<td>The developed graph will be shown on the</td>
</tr>
<tr>
<td>B18</td>
<td>V</td>
<td>monitor.</td>
</tr>
</tbody>
</table>

The developed graph will be shown on the monitor.
In order to "spruce up" the graph the following steps can be taken. These steps will write captions on the graph which will be produced by the software.

<table>
<thead>
<tr>
<th>Pointer at</th>
<th>Enter</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>B18</td>
<td>ESCAPE</td>
<td>Will exit the graph, and will take you to Graph Submenu level.</td>
</tr>
</tbody>
</table>

Move The pointer to TITLES <ENTER>
Move the pointer to 1ST LINE <ENTER>
  ENGR-1 <ENTER>
Move the pointer to 2ND LINE <ENTER>
  QUATTRO DEMO. <ENTER>
Move the pointer to X-AXIS <ENTER>
  Distance (in.) <ENTER>
Move the pointer to Y-AXIS <ENTER>
  Deflection (in.) <ENTER>
  View the completed graph on the monitor.

The hardcopy of the completed graph is shown in Fig. 22. The inspection of the graph shows that the curves corresponding to the deflected shapes of the beams consist of straight line segments. This is due to a basic assumption employed by the spreadsheet programs, e.g., QUATTRO, LOTUS 1-2-3. In reality, it is known that the deflection curves are smooth. If a better representation of the deflected shapes is desired, then a modified spreadsheet can be employed. All steps carried out in Section 4.2 and this section should be repeated with the following modification. The "x" values can be regenerated with "x-increments" of 2 inches, instead of the original value of 12 inches. The length of columns, i.e., columns -A, -B, and -C, will be longer. If a new graph is generated using the new values, the smooth curves shown in Fig. 23 will be obtained.

It should be noted that once the basic crude spreadsheet model is developed, the modifications with finer "x" increments is a simple one to accomplish.
ENGR-1
QUATTRO DEMO.

Fig. 22: Beam Deflection Profiles, increment = 12 in.

Fig. 23: Beam Deflection Profiles, increment = 2 in.
6. MATRIX OPERATIONS

Most spreadsheet software, including QUATTRO, have limited "matrix manipulation" capabilities. QUATTRO has two basic operations; matrix multiplication and matrix inversion. However, by using these two operations it is possible to solve linear set of simultaneous algebraic equations. If the set of equations is given as \[ [A] \{X\} = \{B\} \], \([A]\) can be inverted and post-multiplied by \([B]\), i.e., \(\{X\} = [A]^{-1} \{B\}\), which is the solution of a set of simultaneous equations. This approach is not limited to a single "right-hand-side vector." Thus, a problem defined as \([A] \{X\} = \{B\}\), can still be solved by this approach, i.e., \(\{X\} = [A]^{-1} \{B\}\). In the following sections the operations required for matrix inversion, matrix multiplication, and solution of simultaneous equations are presented.

6.1 Matrix Inversion

a) Enter matrix to be inverted.

b) At master menu select ADVANCED option. At sub-menu select MATRIX option. At sub-sub-menu select INVERSE. (Follow the instructions on the screen, as described below.)

c) Define the "block" which contains the matrix to be inverted by cursor keys. Press ENTER key.

d) Move the highlighted cell to an area where the inverse will be "written." Press ENTER key. The cell you identify corresponds to the location of column-1 and row-1, i.e., \(a_{1,1}\).

e) The inverse will be displayed at the specified area.

6.2 Matrix Multiplication

a) Enter the first matrix, \([A]\).

b) Enter the second matrix, \([B]\).
c) At master menu select ADVANCED option. At sub-menu select MATRIX option. At sub-sub-menu select MULTIPLY. (Follow the instructions on the screen, as described below.)

d) Define the "block" which contains the first matrix, i.e., [A], by cursor keys. Press ENTER key.

e) Define the "block" which contains the second matrix, i.e., [B], by cursor keys. Press ENTER key.

f) Move the highlighted cell to an area where the result \[ [C] = [A] \times [B] \] will be "written." Press ENTER key. The cell you identify corresponds to the location of column-1 and row-1, i.e., \( b_{1,1} \).

g) The result will be displayed at the specified area.

h) WARNING: IN MATRIX MULTIPLICATION, THE DIMENSIONS MUST BE CONSISTENT, I.E., \( C(M,N) = A(M,L) \times B(L,N) \).

6.3 Solution of Simultaneous Algebraic Equations

a) The equations to be solved are defined as \[ [A](X) = (B) \].

b) Enter the coefficient matrix, \([A]\).

c) Enter the "right-hand-side" vector, \((B)\).

d) Invert \([A]\) by using the procedure described above.

e) Multiply matrices \([A]^{-1} \times (B)\) by using the procedure described above. The resultant array will be the solution vector.

f) WARNING: VECTOR \((B)\) SHOULD BE A "COLUMN VECTOR." DIMENSIONS OF \([A]\) AND \((B)\) MUST BE CONSISTENT.
6.4 Example Problem
A set of simultaneous linear algebraic equations are given as:

\[
\begin{align*}
4 & -2 & 1 & x_1 & = 0 \\
-2 & 4 & -2 & x_2 & = 1 \\
1 & -2 & 4 & x_3 & = 0
\end{align*}
\]

The above set of equations can be written in a compact form as

\[ [A] (X) = (B) \]

In order to solve the above problem, the following major operational steps need to be undertaken:

1) Enter matrix-\([A]\) and vector-\((B)\),

2) Invert matrix-\([A]\), \([A]^{-1}\) will be obtained, and

3) Multiply \([A]^{-1} (B)\)

Detailed steps involved for the above operations can be summarized as follows:

1) Enter matrix-\([A]\) at cell locations A1..C3. The cell address locations and numerical values to be entered are:

<table>
<thead>
<tr>
<th>CELL</th>
<th>NUMERICAL VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>4</td>
</tr>
<tr>
<td>B1</td>
<td>-2</td>
</tr>
<tr>
<td>C1</td>
<td>1</td>
</tr>
<tr>
<td>A2</td>
<td>-2</td>
</tr>
<tr>
<td>B2</td>
<td>4</td>
</tr>
<tr>
<td>C2</td>
<td>-2</td>
</tr>
<tr>
<td>A3</td>
<td>1</td>
</tr>
<tr>
<td>B3</td>
<td>-2</td>
</tr>
<tr>
<td>C3</td>
<td>4</td>
</tr>
</tbody>
</table>

2) Enter vector-\((B)\) at cell locations E1..E3. The cell address locations and numerical values to be entered are:
3) Issue the following commands in order to define matrix \([A]\) and to obtain \([A]^{-1}\):

<table>
<thead>
<tr>
<th>COMMAND</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>/</td>
<td>Brings up the master menu.</td>
</tr>
<tr>
<td>A</td>
<td>Brings up the Advanced Submenu.</td>
</tr>
<tr>
<td>M</td>
<td>Brings up the Matrix Submenu.</td>
</tr>
<tr>
<td>I</td>
<td>Defines the operation to be performed as a matrix Inversion.</td>
</tr>
</tbody>
</table>

Define Block A1..C3 as the matrix to be inverted.  
(Follow the instructions on the screen.)

Enter A5 as the upper left hand corner of the block where your results will be written. <RETURN>

The inverse of the matrix will be written in block A5..C7.

4) Issue the commands to perform the matrix multiplication \([A]^{-1}(B)\), the result of which will be \((X)\):

<table>
<thead>
<tr>
<th>COMMAND</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>/</td>
<td>Brings up the master menu.</td>
</tr>
<tr>
<td>A</td>
<td>Brings up Advanced Submenu.</td>
</tr>
<tr>
<td>M</td>
<td>Brings up Matrix Submenu.</td>
</tr>
</tbody>
</table>
| M       | Matrix multiplication command is issued.  
  (Follow the instructions on the screen.) |

Define the 1ST MATRIX, which is \([A]^{-1}\). It is located in block A5..C7.

Define the 2ND MATRIX, which is \((B)\). It is located in block E1..E3.

Define the upper left hand corner of the block where the resultant matrix, \((X)\) will be written.
7. REGRESSION

QUATTRO, as well as most other spreadsheet software, has limited "least squares curve fit" capabilities. If the statistical analyses to be performed are of sufficient complexity, i.e., beyond the simple curve fit, then the use of dedicated statistical software packages, e.g., STATGRAPHICS, is recommended. Most microcomputer-based statistical software have the capability of reading LOTUS 1-2-3, or QUATTRO, generated spreadsheets. These spreadsheets may contain the "raw data," which will be manipulated by these statistical packages.

The basic curve fitting offered by QUATTRO is limited to the linear fit, i.e. $y = a + bx$, where "a" and "b" are the coefficients to be determined by the regression analysis to be performed by QUATTRO. In some cases the data points can clearly indicate that a linear curve fit in the form of $y = a + bx$ will lead to highly inaccurate representation of the data. Some other forms of curve fit, e.g., $y = a \ln(bx)$, may be more appropriate. In order to get such "curve fits," first the raw data need to be subjected to some transformation, e.g., $(x_1, y_1)$ pair will be modified to $(\ln(x_1), \ln(y_1))$. The straight line curve fit then can be applied to this new data set.

The use of "straight line curve fit," "data transformation" will be illustrated via an example problem.

7.1 The Description of the Problem and Data Entry

A test is conducted and 19 data pairs are obtained, shown as below:

<table>
<thead>
<tr>
<th>X (TIME)</th>
<th>Y (STRENGTH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(DAYS)</td>
<td>(PSI)</td>
</tr>
<tr>
<td>1</td>
<td>575</td>
</tr>
<tr>
<td>2</td>
<td>800</td>
</tr>
<tr>
<td>3</td>
<td>900</td>
</tr>
<tr>
<td>7</td>
<td>1175</td>
</tr>
<tr>
<td>14</td>
<td>1600</td>
</tr>
<tr>
<td>21</td>
<td>1850</td>
</tr>
<tr>
<td>28</td>
<td>2000</td>
</tr>
<tr>
<td>35</td>
<td>2100</td>
</tr>
</tbody>
</table>

(Continued...)
The above data points can be seen in Fig. 24, which is obtained using QUATTRO.

**Fig. 24: Raw Data**
Steps involved in entering the data for the regression analysis are described below:

1) Enter a caption CURVE FIT USING QUATTRO and (RAW DATA) to cells A1 and B1, respectively. This will prevent confusion in future identification of the spreadsheet. Enter the captions of "X (TIME)", "Y (STRENGTH)", "(DAYS)", "(PSI)" to cells A1, A2, C1, and C2, respectively. These will provide descriptive captions for the tabulated raw data.

2) Enter the "X-data" given above to cells A5 through A23. Enter "Y-data" given above to cells B5 through B23. (At this time issue a File Save command to prevent possible mishaps.)

7.2 Regression Analysis
Perform the regression analysis by issuing the following commands:

<table>
<thead>
<tr>
<th>COMMAND</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>/</td>
<td>Brings up the master menu.</td>
</tr>
<tr>
<td>A</td>
<td>Brings up the Advanced Submenu.</td>
</tr>
<tr>
<td>R</td>
<td>Brings up the Regression Submenu.</td>
</tr>
</tbody>
</table>

(issue the "I" command to identify the "independent" data block.

Enter a "." at cell A5; this will anchor the block.

By using DOWN ARROW KEY move the highlighted area, i.e., the block, to cover cells A5 through A23. <RETURN>

Issue "D" command to identify the "dependent" data block.

Enter a "." at cell B5; this will anchor the block.

By using DOWN ARROW KEY move the highlighted area, i.e., the block, to cover cells B5 through B23. <RETURN>

Issue "O" command. This will define the "location" to display the results. Move the highlighted cell to A25 and press the RETURN KEY. This cell will be the "upper left hand corner" of the block where the results of the regression analysis will be written.
Issue "Y" command. This permits you to force the "straight line curve fit" either to pass through the origin of the coordinate system (by issuing "zero" as the choice) or to have the "y-axis intercept" be computed by the software (by issuing GO as the choice).

Below the regression analyses results using the options of the curve fit going through the origin (Constant=0.) and automatic computation of the "y-intercept," (Constant=1575.244) are shown. The results shown below correspond to two different regression analyses.

**LINEAR REGRESSION**

**X SV. Y**

![Graph showing raw data and two straight line fits.](image)

**Fig. 25: Raw Data and Two Straight Line Fits**
The output clearly shows the equation of the "fitted straight line." These two lines, one with zero intercept and the other one with software computed intercept, as well as the raw data points, are shown in Fig. 25.

It can easily be seen that both curve fits represent the data poorly. In the case of "zero-intercept fit," marked by asterisks, there is a substantial deviation from the raw data! Instead of inspecting the graph it is also possible to arrive at conclusions by studying the output of the regression analysis written by the software. "R-squared" term is a statistic measuring the validity of a given "least square fit." The numerical value of this term, for "plausible" curve fits, varies from zero to one, \( r^2 = 1.0 \) being the optimal fit. In the "zero intercept case" the \( r^2 \) is a negative value, indicating a complete unreliability of this regression analysis. Whereas, in the other curve fit, the value is \( r^2 = 0.52 \ldots \) indicating a very poor correlation between the raw data and the fitted straight line, (\( r^2 = 1 \) is the optimal case!)

### 7.3 Nonlinear Regression Analysis

As seen above, the "straight line curve fit" results in poor results. Inspection of the raw data points, and using the basic statistical understanding suggests that a better curve fit would be in the form of "\( y = a \ln(b \cdot x) \)." By "changing" the numerical values of the "raw data," i.e., via "coordinate transformations," the linear regression analysis option available in QUATTRO can still be employed.

The data pairs in columns A and B can be copied to columns D and E as follows:

<table>
<thead>
<tr>
<th>Cell Location</th>
<th>Command</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>D5</td>
<td>@LN(A5)</td>
<td>Puts ( \ln(x_i) ) at cell D5.</td>
</tr>
<tr>
<td>E7</td>
<td>@LN(B5)</td>
<td>Puts ( \ln(y_i) ) at cell E5.</td>
</tr>
<tr>
<td>D5</td>
<td>/</td>
<td>Brings up the master menu.</td>
</tr>
<tr>
<td>D5</td>
<td>B</td>
<td>Brings up Block Submenu.</td>
</tr>
<tr>
<td>D5</td>
<td>C</td>
<td>Issues the Copy command.</td>
</tr>
<tr>
<td>D5</td>
<td>&lt;ENTER&gt;</td>
<td>Identifies the cell to be copied.</td>
</tr>
<tr>
<td>Cell Location</td>
<td>Command</td>
<td>Comments</td>
</tr>
<tr>
<td>---------------</td>
<td>------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>D6</td>
<td>&quot;/&quot;</td>
<td>Anchors the block where the contents of cell D6 will be copied.</td>
</tr>
<tr>
<td>D6-D23</td>
<td>DOWN ARROW KEY</td>
<td>Defines the block.</td>
</tr>
<tr>
<td></td>
<td>&lt;ENTER&gt;</td>
<td></td>
</tr>
<tr>
<td>E5</td>
<td>&gt;</td>
<td>Brings up the master menu.</td>
</tr>
<tr>
<td>E5</td>
<td>B</td>
<td>Brings up Block Submenu.</td>
</tr>
<tr>
<td>E5</td>
<td>C</td>
<td>Issues the Copy command.</td>
</tr>
<tr>
<td>E5</td>
<td>&lt;ENTER&gt;</td>
<td>Defines the block.</td>
</tr>
<tr>
<td>E6</td>
<td>&quot;/&quot;</td>
<td>Anchors the block where the contents of cell E6 will be copied.</td>
</tr>
<tr>
<td>E6-E23</td>
<td>DOWN ARROW KEY</td>
<td>Defines the block.</td>
</tr>
<tr>
<td></td>
<td>&lt;ENTER&gt;</td>
<td></td>
</tr>
</tbody>
</table>

By using the procedure described in Section 7.2 a new curve fit can be performed. The results of this curve fit are shown in Fig. 26. The $r^2$ for this new curve fit is 0.916386, indicating a good curve fit to the given data points. It should be noted that the axes of this new curve fit are $ln(x)$ vs. $ln(x)$.

![Graph](image.png)

Fig. 26: Raw Data and Straight Line Fit to "$ln(x)$ vs. $ln(y)$" Data
The database management capabilities of any spreadsheet software are quite limited as compared to any full-blown database management software, e.g., PARADOX. However, some limited database operations can be carried out via QUATTRO. This chapter gives a simple application of the database capability of the program.

8.1 Example Problem: Class List
A small ENGR-1 course section is entered on the spreadsheet shown below. The first three rows contain captions. Cells A4 through A15 contain the last names of the students. Cells B4 through B15 contain the initials of the students. Cells C4 through C15 contain the total semester grade of the student.

<table>
<thead>
<tr>
<th>ENGR-1. SECTION-19</th>
<th>FALL, 1989</th>
<th>LAST NAME</th>
<th>FIRST NA.</th>
<th>GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZYLOWSKI</td>
<td>A.</td>
<td>1200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AARDWARK</td>
<td>Z.</td>
<td>331</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KANE</td>
<td>G.</td>
<td>1001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BOLLE</td>
<td>D.</td>
<td>575</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SANCHEZ</td>
<td>P.</td>
<td>1111</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KARAKASH</td>
<td>J.</td>
<td>998</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VANHORN</td>
<td>L.</td>
<td>1002</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RADIN</td>
<td>S.</td>
<td>1251</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KAZAKIA</td>
<td>D.</td>
<td>887</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CLUMP</td>
<td>C.</td>
<td>1121</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HARVILL</td>
<td>P.</td>
<td>776</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INAN</td>
<td>M.</td>
<td>1260</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The first application is to find the section mean, standard deviation, maximum section score, and minimum section score. The additional captions for MEAN, STANDARD DEVIATION, etc. are added for the sake of readability. The formulas in cells will be entered. Upon the entry of each formula the numerical value of the result will be displayed, as shown below.
<table>
<thead>
<tr>
<th>LAST NAME</th>
<th>FIRST NAME</th>
<th>GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZYLOWSKI</td>
<td>A.</td>
<td>1200</td>
</tr>
<tr>
<td>AARDWARK</td>
<td>Z.</td>
<td>331</td>
</tr>
<tr>
<td>KANE</td>
<td>G.</td>
<td>1001</td>
</tr>
<tr>
<td>BOLLE</td>
<td>D.</td>
<td>575</td>
</tr>
<tr>
<td>SANCHEZ</td>
<td>P.</td>
<td>1111</td>
</tr>
<tr>
<td>KARAKASH</td>
<td>J.</td>
<td>998</td>
</tr>
<tr>
<td>VANHORN</td>
<td>L.</td>
<td>1002</td>
</tr>
<tr>
<td>RADIN</td>
<td>S.</td>
<td>1251</td>
</tr>
<tr>
<td>KAZAKIA</td>
<td>D.</td>
<td>887</td>
</tr>
<tr>
<td>CLUMP</td>
<td>C.</td>
<td>1121</td>
</tr>
<tr>
<td>HARVILL</td>
<td>P.</td>
<td>776</td>
</tr>
<tr>
<td>INAN</td>
<td>M.</td>
<td>1260</td>
</tr>
</tbody>
</table>

Mean: 959.4167
Standard Deviation: 269.094
Maximum Score: 1260
Minimum Score: 331

If there is a need to alphabetically sort the names of the students the following commands need to be issued.

<table>
<thead>
<tr>
<th>COMMAND</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>/</td>
<td>Brings up the Master Menu.</td>
</tr>
<tr>
<td>A</td>
<td>Brings up the Advanced Submenu.</td>
</tr>
<tr>
<td>S</td>
<td>Brings up the Sort Submenu.</td>
</tr>
<tr>
<td>B</td>
<td>Issue the command to define the block to be sorted. By using &quot;.&quot; and arrow keys define the highlighted area which will include the ALL the names of the students and the grades. It will NOT include any captions or formulae.</td>
</tr>
</tbody>
</table>

1ST KEY
| A       | Move the highlighted cell to the first column. |

2ND KEY
| A       | The block will be sorted in ASCENDING ORDER (i.e., A-Z and 0-9). |
|         | Move the highlighted cell to the second column. |

The block will be sorted in ASCENDING ORDER (i.e., A-Z and 0-9), just in case if there are identical names in the first column. It will then consider the
first initial in sorting.
Issue GO command the data contained in the block will be displayed in a sorted order. (Note that the numerical results of MEAN, STANDARD DEVIATION, etc. remain unchanged.
Reset option will clear all the "sorting keys."

The following is the outcome of the above defined operations.
ENGR-1, SECTION-19
FALL, 1989
LAST NAME FIRST NA.   GRADE
AARDWARK Z. 331
BOLLE D. 575
CLUMP C. 1121
HARVILL P. 776
INAN M. 1260
KANE G. 1001
KARAKASH J. 998
KAZAKIA D. 887
Radin S. 1251
SANCHEZ P. 1111
VANHORN L. 1002
ZYLOWSKI A. 1200

MEAN   959.4167
STANDARD DEVIATION 269.094
MAXIMUM SCORE 1260
MINIMUM SCORE 331

If we need to sort the data, for example, based on the student grades, the following steps need to be taken.

<table>
<thead>
<tr>
<th>COMMAND</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>/</td>
<td>Brings up the Master Menu.</td>
</tr>
<tr>
<td>A</td>
<td>Brings up the Advanced Submenu.</td>
</tr>
<tr>
<td>S</td>
<td>Brings up the Sort Submenu.</td>
</tr>
</tbody>
</table>
| B        | Issues the command to define the block to be sorted. By using "." and arrow keys define the highlighted area which will include ALL the names of the
students and the grades. It will NOT include any captions or formulae.

1ST KEY
Move the highlighted cell to the third column.
A
The block will be sorted in ASCENDING ORDER (i.e., A-Z and 0-9).

2ND KEY
Move the highlighted cell to the first column.
A
The block will be sorted in ASCENDING ORDER (i.e., A-Z and 0-9), just in case there are identical grades in the third column. It will then consider the last name in sorting.
G
Issue GO command so the data contained in the block will be displayed in a sorted order.

The results of the sorting operation described above are shown below.

<table>
<thead>
<tr>
<th>LAST NAME</th>
<th>FIRST</th>
<th>GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>INAN</td>
<td>M.</td>
<td>1260</td>
</tr>
<tr>
<td>RADIN</td>
<td>S.</td>
<td>1251</td>
</tr>
<tr>
<td>ZYLOWSKI</td>
<td>A.</td>
<td>1200</td>
</tr>
<tr>
<td>CLUMP</td>
<td>C.</td>
<td>1121</td>
</tr>
<tr>
<td>SANCHEZ</td>
<td>P.</td>
<td>1111</td>
</tr>
<tr>
<td>VANHORN</td>
<td>L.</td>
<td>1002</td>
</tr>
<tr>
<td>KANE</td>
<td>G.</td>
<td>1001</td>
</tr>
<tr>
<td>KARAKASH</td>
<td>J.</td>
<td>998</td>
</tr>
<tr>
<td>KAZAKIA</td>
<td>D.</td>
<td>887</td>
</tr>
<tr>
<td>HARVILL</td>
<td>P.</td>
<td>776</td>
</tr>
<tr>
<td>BOLLE</td>
<td>D.</td>
<td>575</td>
</tr>
<tr>
<td>AARDWARK</td>
<td>Z.</td>
<td>331</td>
</tr>
</tbody>
</table>

| MEAN | 959.4167 |
| STD  | 269.094  |
| MAX  | 1260     |
| MIN  | 331      |

50
QUATTRO is capable of performing many additional "database related" operations. However, these are beyond the scope of this guide.