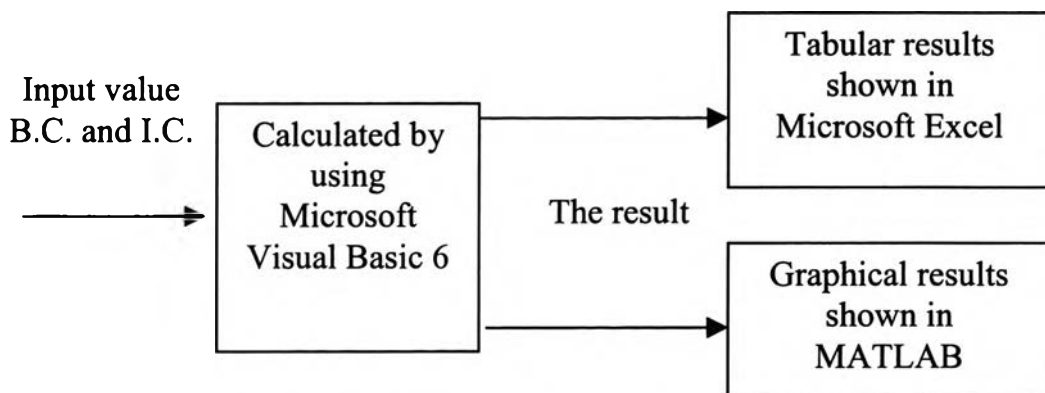


## CHAPTER VI

### DISCUSSION

#### 6.1 The Process of the Program

This program can solve partial differential equations by using Microsoft Visual Basic 6 and the results are divided into two parts. The first part is the numerical results shown as a table in Microsoft Excel and the second is the graphical results shown by the MATLAB software. One of the advantages of this solver is that it is very convenient to use. The user just follows the direction guide shown on the graphical user interface of this program without writing a program in a programming language. The results are displayed on the monitor after the calculation



**Figure 6.1** The diagram of the solver program.

## 6.2 Input Value

The user has to input some necessary values for limiting the grid size, boundary conditions, initial conditions, and the size of sample, etc.

**Figure 6.2** Example of some input values.

The coefficients which are in front of the derivative of  $x$ ,  $y$ , and  $z$  are  $a$ ,  $b$ , and  $c$  respectively. The user should compare the equation which they want to solve with the general second-order equation shown at the top of the program solver.

$$a \frac{\partial^2 u}{\partial x^2} + b \frac{\partial^2 u}{\partial y^2} + c \frac{\partial^2 u}{\partial z^2} = f(x, y, z) \quad (6.1)$$

The  $\Delta X$ ,  $\Delta Y$ , and  $\Delta Z$  define the grid size in the x-, y- and z-directions, and  $\Delta T$  is the increment for the time range.  $Const$  is a constant value on the right hand side of the elliptic equation. The user has to input the size of the sample in the length of x for the x-direction, length of y for the y-direction, and length of z for the z-direction. The maximum time is the total time of the calculation. The frequency values for x, y and z are used for showing some values of the results. For boundary conditions, the user has to specify the initial guess for elliptic equations, initial conditions for parabolic equations, and the exact value for each edge.

### 6.3 Out Put

#### 6.3.1 Microsoft Excel Sheet

The results in the Microsoft Excel spreadsheet will show partial differential equation, all input values, initial condition ,and boundary conditions. The numerical results are shown below these values.

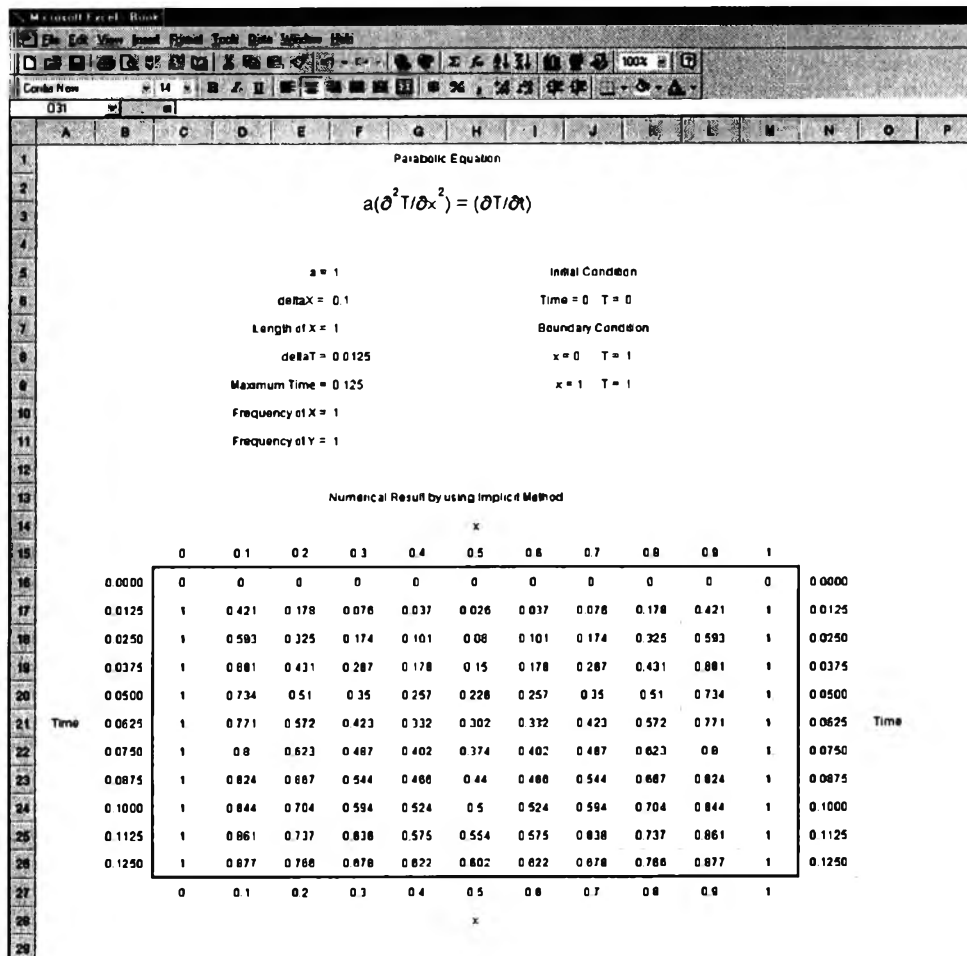
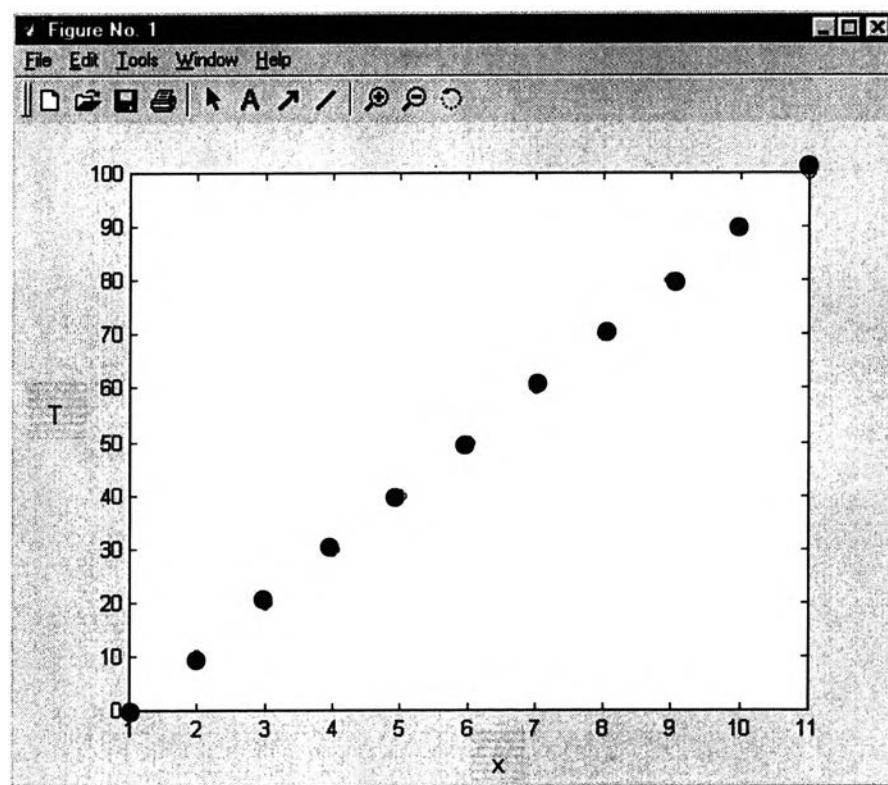


Figure 6.3 The tabular results are shown by Microsoft Excel.

### 6.3.2 MATLAB

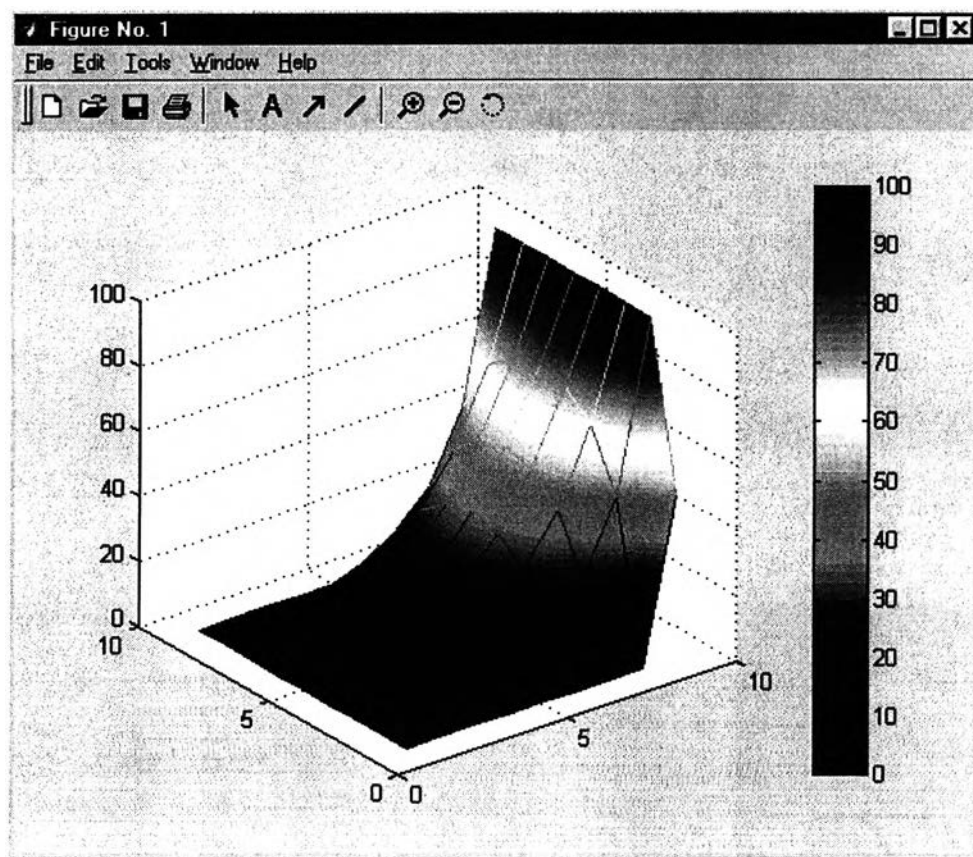
The graphical results shown by MATLAB Graphic will be different, depending on the type of equation.

For the one-dimensional elliptic equation, the plot function of MATLAB is used to show the graphical results.



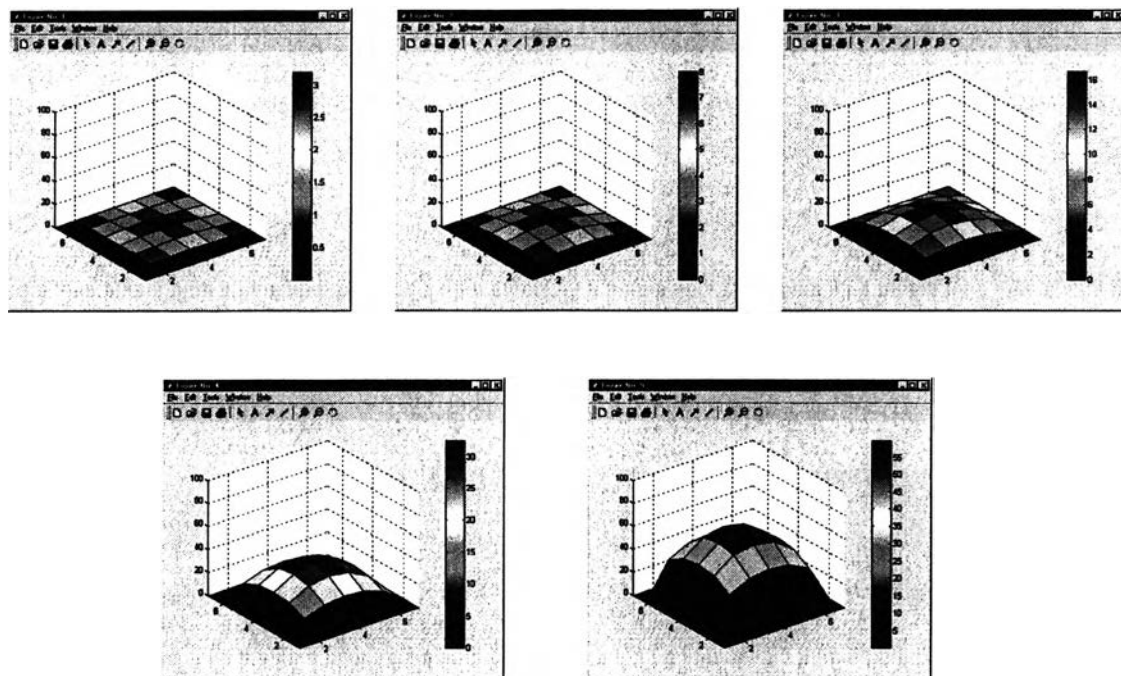
**Figure 6.4** The graphical results using the plot function in MATLAB.

For two-dimensional elliptic equations, the Surf function of MATLAB is used to show the graphical results. From Fig.6.4, the color map on the right side of the graph uses color to show the different temperature values.



**Figure 6.5** The graphical results using the surf function in MATLAB.

For three-dimensional elliptic equations, the Surf function of MATLAB is used to show the graphical results. We cannot show all of the results in one figure. Consequently, the results are shown in separated plots with different  $z$  values. There are several figures used for showing the results in each grid in the  $z$ -direction. The number of figures depends on the range of the  $z$ -direction.



**Figure 6.6** The graphical results for three-dimensional elliptic equations using the surf function show the results in separated plots with different  $z$  values in MATLAB.

For the one-dimensional parabolic equation, the `plot` function is used to show the result of each time step value and the `getframe` function is used to capture each plot figure. Afterward, the results are shown by the `movie` function like an animation. The little changes of each figure makes the picture look like it is moving.

For the two-dimensional parabolic equation, `surf` function is used to show the results of in two dimensions of at each time step value. As in one dimension, the `getframe` function is used to capture each mesh figure; then the `movie` function is used to show the moving figure.



#### 6.4 The Disadvantages of Program

The MATLAB graphical results programmed by using Excel Link in MATLAB are fixed and limited to some values of result parameters. The programmer had to program all the codes to change parameters. This problem was found in three-dimensional elliptic equations, one- and two-dimensional parabolic equations.

For three-dimensional elliptic equations, the results are shown in separated plots with different  $z$  values. The number of figures depends on the number of  $z$  intervals, which can be calculated from the user's input values but creating figures had to be programmed by Excel Link where the exact number of the figures should be specified before. The program can be corrected by changing the number of figures in the program, which makes program too big.

For one- and two-dimensional parabolic equations, the problem is the same as for three-dimensional elliptic equations. The number of figures depends on the number of time intervals which had to be programmed by Excel Link.