EESy Solutions

Engineering Equation Solver Newsletter *No. 17, Spring 2007*

Welcome

EESy Solutions is a newsletter developed to provide news, tips, and tricks relating to Engineering Equation Solver. **EESy Solutions** is provided at no cost to all users of EES. Did you miss any of the previous issues? These newsletters and other useful information can be downloaded from our web site: www.fchart.com.

Instant Update Service

EES is updated more frequently than most other commercial software. Each time there is a change in the program either to correct a problem or to add a new feature, the version number is incremented by 0.001 and the latest version is placed on our website. There have been over 280 new versions released since the last EESy Solutions was composed in Spring 2006. Any user who has Instant Update Service can download the latest version. All new licenses of EES are provided with one year of Instant Update Service. If your version of EES was purchased within the last twelve months, you can access the Instant Update server conveniently with the EES Instant Update menu item in the Help menu. The fee to continue Instant Update Service after the first year is 20% of current cost of the program per year. Contact F-Chart Software or use the website (fchart.com) if you wish to re-subscribe to Instant Update Service.

Academic Site Licenses

Both Academic and Academic/Professional site licenses are available to departments in educational institutions for a one-time fee of $1,000 and $3,750, respectively. See www.fchart.com for additional details.

What's New?

As in years past, literally hundreds of changes have made to EES during the past year. The capabilities of the program continue to grow. What follows is a short description of some of the more important new capabilities.

Support for Vista

Microsoft released its long-awaited new operating system, Vista, in January, 2007. EES works with Vista, but the help files that EES uses for both internal and external functions did not work. Vista does not support the .hlp files and the WinHlp32 application that has been the standard for previous operating systems. Consequently EES has been modified to recognize and work with compiled HTML help files (.chm). The help for libraries has been converted to this format.

Visual Accessed Library Files

A method to visually access library files has been added to the Function Information dialog. Each function in these libraries is associated with a small bitmap picture. Click on the lower right button in the button group shown at the top to access this library. A drop-down list of library files is available that currently provides visual access to libraries for a) Fin efficiencies; b) Heat exchanger effectiveness; c) Shape Factors; and d) View Factors. More extensive libraries have been developed for the textbook: Intermediate Heat Transfer with Software Tools; G.F. Nellis and S.A. Klein, 2009. Additional libraries can be added by users, as explained in the on-line help.

Compressed .EEZ Files

EES programs can require a lot of disk storage, particularly if graphic items are used in the Diagram window. The Professional version provides the option of saving and reading compressed .EES files. These files have an .EEZ filename extension. All versions of EES starting with Version 7.659 can read .EEZ files. Distributable programs created by EES can be automatically zipped. The zip file contains the .exe file and supporting files in the \USERLIB folder that are needed for it to operate.

Two-Monitor Support

Two-monitor support is provided for the main EES windows in the Professional version. Clicking the 2-monitor display button at the right of the title bar (next to the minimize, maximize and close buttons) allows the window to dragged outside of the bounding EES window

USERLIB Folder Changes

The USERLIB folder contains optional library files written by the user and others. This folder has been rearranged to make it more convenient to add and remove libraries. EES will now load files that are nested within subdirectories within the USERLIB directory. Shortcut (or link) files can now be placed in the UserLib folder. EES will open the directory specified by the shortcut and load the library files at startup. Library files in the USERLIB\EES_System folder are loaded before any other library files. Library files that are called by other library files and thus need to be loaded first can be placed in this folder.

Unit Specifications

Unit specifications with negative exponents can be entered and the separator between units can be a space (rather than a -). For example, the following EES unit assignments are all equivalent.

A=5 [W m-2 K-1]
B=5 [W/m^2-K]
C=5 [W/(m^2 K)]
D=5 [W m^-2 K^-1]

Contour and Gradient Plots

Contour and surface plots provide the option to show a full spectrum of colors in addition to the red to blue colors that was provided in earlier versions. Contour plots provide the option to display gradient arrows. The arrows point the direction of the gradient with the length of the arrow shaft being proportional to the magnitude of the gradient. The Professional version allows overlay plots on an existing contour plot.

$IF and $IFNOT Improvements

The $IF and $IFNOT directives will accept the following keywords:

MinmaxTable='table name', Uncertainty, UncertaintyTable, and UncertaintyTable='table name'.

The $IF/IFNOT directive can accept a second condition separated by the OR keyword, e.g., $IFNOT ParametricTable OR MinMax.

Plot Window Status Bar

A status bar appears at the bottom of the plot window when the coordinate crosshair option is chosen from the toolbar (or when the Ctrl-Shift keys are depressed). The status bar shows the location of the cursor in the plot window coordinates. This information was previously displayed in the window title.

Plot Templates

The ability to save and apply plot templates has been added to the Professional version. Access to plot templates is provided by right-clicking on the tab at the top of the plot window. Using plot templates is the easiest way to ensure that all of your plots have a consistent appearance.

Complex Variable Improvements

Unit checking has been implemented for the complex number mode. Subprograms can be configured to operate with complex variables by placing a $Complex ON directive within the text of the Subprogram. The $Complex ON directive can be followed by an i or j to indicate which symbol is to represent the square root of -1.

Parametric and Lookup Table Enhancements

If you right-click the mouse on any table (Parametric, Lookup, Arrays, or Integral) when table cells are selected, a popup menu will appear that provides many of the same options that are available in the main menu. However, one additional option is Copy (E-Format). Copy and Copy with Headers copy the selected data in the table with exactly the number of significant figures that are displayed. Copy (E-Format) will copy the values with 12 significant figures. These data can then be pasted into another column in a table with no loss in accuracy.

Warning Dialog Control

A dialog appears when warnings occur during the calculations. An option is now provided to avoid showing this dialog more than once. Warnings can be viewed by selecting the Warning menu item in the Windows menu.

New Macro Commands (Professional version)
Multiple assignments can be specified in one line of a Macro file, provided that they are separated by a line break character (;).

A DELETELookup 'tablename' has been added to the list of Macro commands. The table name can be specified as a string constant (in single quotes), as a string variable, or as an integer indicating the position of the table with the first table being number 1.

The OpenLookup Macro command can provide a ? in place of a filename. In this case, EES will present a file selection dialog to choose the file name.

The Macro Plot and OverlayPlot commands accept the name of the table to be plotted if it is surrounded in single quotes, e.g., 'myTable'. The older format in which the table is indicated by the table type and tab number, e.g., PAR2 or LOOK3, is still supported.

The SaveLookup, SaveTable and SaveArrays Macro commands have been extended.

SaveLookup 'Lookup 1' myTable.txt /A /T /N /E

will save the contents of the Lookup table having the tab name 'Lookup 1' to a file called mytable.txt. If ? is provided in place of the file name, a dialog will appear to enter a file name. The following options can be applied if the saved file is a .txt or .csv file. If /A is provided as an option and the file exists, the current information in the table will be appended to the existing file. If /T is provided, the data in the file will be transposed. If /N is provided, the column name and units will be written, followed by the data in the table. If /E is provided, the file will be written in a format that can be read as an EES Lookup Table

IF THEN ELSE and GOTO commands are implemented in Macro files. GOTO is followed by a statement label number, e.g., 10. A statement label must exist, identified by the label number followed by a colon, e.g., 10: x=x+1

Tips and Tricks

EES has been designed to be easy to use. New users are typically able to solve problems within 15 minutes of introduction to the program. Like any complex program, however, EES provides a number of short-cuts and conveniences that simplify its use. Here are a few of our favorites.

Compiler Directives
Compiler directives are instructions to the EES equation pre-processor that begin with a $ character. EES provides a large number of compiler directives that can be of use even with simple programs. Perhaps the most useful directives are the $IF / $IFNOT directives that programmatically include or exclude selected equations during the compiling process. For example, consider the following program:

```
b=77
x^2+y^3=b
x/(y^2+sqrt(x))=2
```

This program should solve with x = 8.875 and y = -1.208. However, now you wish to determine the values of x and y for a range of values of b. You create a Parametric table with columns for b, x, and y. The values of b you wish to consider are entered into the table. However, your program will no longer run because b is specified in both the Equations window (to be 77) and in the Parametric table. You could just delete or comment out the b=77 equation, but in some cases, it is convenient to have the program run both as a Parametric table and for a single set of values. This dual behavior can be accomplished by using a directive, as follows:

```
$IFNOT ParametricTable
b=77
$ENDIF
x^2+y^3=b
x/(y^2+sqrt(x))=2
```

The b=77 equation will be included if you are not running the Parametric table but excluded if you are using the table. No further changes are required. The $IF/IFNOT directive provides many conditions that can be tested , e.g, use of the Diagram window or the Min/Max command.

Use of Modules/Subprograms

Modules and Subprograms are like EES programs that can be called from the main EES program. They differ from Procedures, which also can be called from the main program, in that the equations in Modules/Subprograms are equalities rather than assignment statements. The equations in Modules and Subrograms can be placed in any order and the structure of the equation does not matter. It is not necessary to isolate the variable that is being solved for on the left of the equation. Modules and Subprograms differ from each other in a subtle way. The equations in a Module are actually solved with the equations in the main program, if possible, whereas the equations in a Subprogram are always solved as a separate unit. The convergence characteristics of these two alternatives differ, so it may be necessary to experiment with both to determine which is better for a particular situation.

A common use a Module/Subprogram is to numerically determine a partial derivative. For example, suppose that you need to determine the partial derivative $\left(\partial v/\partial T\right)_P$ from the Peng-Robinson equation of state that relates the pressure (P), temperature (T) and specific volume (v). The Peng-Robinson is implicit in v, so numerical differentiation is required. This can be easily accomplished by providing a Subprogram to solve for v given P and T. The Subprogram is called several times with different values of T to determine the numerical derivative, as in the following example.

```
subprogram P_PR(T, P, T_c, P_c, w: v)
    P=(R#*T)/(v-b)-a/(v*(v+b)+b*(v-b))
    a_c=0.45724*R#^2*T_c^2/P_c
    kappa=0.37464+1.54226*w-0.26992*w^2
    a=a_c*(1+kappa*(1-sqrt(T/T_c)))^2
    b=0.07780*R#*T_c/P_c
end

T = 400 [K];  P=5000 [kPa]
T_c=T_crit(CH4);  P_c=P_crit(CH4);
w=acentricFactor(CH4)

call P_PR(T, P, T_c, P_c, w: v)
T|plus=1.001*T;  T|minus=0.999*T
call P_PR(T|plus, P, T_c, P_c, omega: v|plus)
call P_PR(T|minus, P, T_c, P_c, omega: v|minus)
dv\dT=(v|plus-v|minus)/(T|plus-T|minus)
```

Integration and the IntegralTable

EES provides powerful tools for numerical integration that can be used to solve differential equations. For example, suppose you wish to solve the following differential equation.

$$\frac{dy}{dt} = y^2 t + 2\left(y+1\right)t^2$$

knowing y=0 at t=0. The Integral function can be used to solve the problem as shown:

```
dy\dt=y^2*t+2*(y+1)*t^2
t_start=0
t_stop=1
t_step=0
y=y_o+integral(dy\dt,t,t_start,t_stop,t_step)
y_o=0
```

When EES encounters the equation with the Integral function, it will set up the logic to vary the integration variable (t in this case) from t_start to t_stop with a step size of t_step. All equations that depend on the integration variable will be repeatedly solved with the current value. The step size parameter is optional. If a step size is not provided or if it is set to zero as in the above example, EES will use an internally selected size that depends on the settings in the Integration tab of the Preferences dialog. It is a always a good idea to check the effect of the step size when doing numerical integration.

The above program determines the value of y at t_stop, but you might also want to know how y varies with t. This information can be easily collected by using the $INTEGRALTABLE directive. For example, placing the following directive at the end of the program will generate an Integral table with columns for t (at intervals of 0.1) and the corresponding value of y.

```
$integralTable t:0.1,y
```

Format Equations Units Display

The Formatted Equations window displays the equations in the Equations window in a mathematical format that is easy to read. However, it can also show the units of constants and variables used in the equations thereby making it easier to check for unit consistency. To display units, right-click the mouse anywhere in the Formatted Equations window and select the options from the popup menu that appears.