EESy Solutions

Engineering Equation Solver Newsletter ***No. 5, Spring 1998***

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 registered users of EES. Did you miss any of the four previous issues of **EESy Solutions**? These and other goodies can be downloaded from: www.fchart.com.

WCB/McGraw-Hill Academic License

F-Chart Software and WCB/McGraw-Hill have reached an agreement in which academic versions of EES will be distributed to educational institutions exclusively by WCB/McGraw-Hill. Under the current plan, academic versions of EES will be provided at no cost to educational departments that adopt selected WCB/McGraw-Hill textbooks including: *Thermodynamics: An Engineering Approach,* 3rd edition, by Yunus A. Cengel and Michael A. Boles, and *Heat Transfer: A Practical Approach* by Yunus A. Cengel. Educational problems that employ innovative applications of the EES Diagram Window have been developed for these two textbooks. WCB/McGraw-Hill will also provide academic versions of EES independent of these textbooks for a fee. Existing academic licenses provided by F-Chart Software are not affected by this agreement. F-Chart Software will continue to distribute commercial versions of EES. The WCB/McGraw-Hill website is http://www.mhhe.com/engcs/mech/ees/.

The times, they are a changin…

This issue will focus on the many new features that have been added to the Windows 32-bit version of EES. However, before describing these new features, some comments regarding other operating systems are in order.

Macintosh Versions

Long-term users will recall that EES was born on a Macintosh. Even after the DOS, Windows, and Unix versions of EES were developed, the Macintosh enjoyed the distinction of being the premier version of EES. Up to about one year ago, all new features were first developed on the Macintosh before they were ported to the other operating systems. Sadly, that is no longer the case. We have had very few new sales for Macintosh versions of EES and as a result, we can no longer justify the time investment necessary to implement the new features that have been added to the Windows version. New versions of EES for all Macintosh platforms are available, but these new versions only correct bugs and implement minor improvements. We encourage our Macintosh users to consider moving to the Windows version.

DOS Version

We no long support the DOS version of EES. If you still use the DOS version, please consider upgrading to Windows.

Unix Version

A beta Unix version of EES was developed several years ago but it was never formally released. As with the Macintosh, we did not find enough interest to warrant its upkeep.

16-bit Windows Version

The 32-bit version of EES was released about one year ago. At that time, the 16-bit and 32-bit versions had identical features. The only difference was that the 32-bit version could not be run under Windows 3.1 and, under Windows 95 and NT, the 32-bit version was much faster than the 16-bit version. Almost everyone has now converted to 95 or NT and consequently, most of the new features described below have been implemented only in the 32-bit version.

What's New?

Many of our users purchased or updated their version of EES last spring. Listed below are the major new features that have been added since that time. New features are added incrementally (almost daily) so if your version of EES was acquired recently, it may already include some of these features.

Menu Speedbar

A menu speedbar has been implemented to provide one-button access to the most commonly

applied menu commands.

Modules

Modules are stand-alone EES subprograms that can be called from the main EES program. The format of a module is similar to that for an internal procedure. However, EES modules employ equalities (as used in the main body of EES) rather than assignment statements as used in procedures. As a result, the equations in a module can be entered in any order with unknown variables placed anywhere within the equations. EES will automatically use iterative techniques, if needed, to solve the equations.

A module is accessed with a CALL statement. When EES encounters a CALL statement, it transparently grafts the equations in the module to the equations in the main program. The steps necessary for this process are as follows. First, every variable in the module, including the input and output variables in the MODULE statement, is renamed with a unique qualifier. Then EES adds one equation for each parameter in the CALL statement to set the value of the parameter in the main program to the value of the variable in the module. Finally, all of the equations in the module, with their renamed variables, are merged into the EES program. If the module is called a second time, the process is repeated, but with a different qualifier for the variable names in the module. The net effect is that a copy of all of the equations in the module are merged into the main EES program each time a CALL statement is encountered. The Solution window can (optionally) display all sets of local values of the variables in the modules.

Modules may be stored as library files, just like internal functions and procedures. They are automatically loaded if they are placed in the USERLIB subdirectory or manually loaded with the $INCLUDE directive or Load Library command. Help can be included within a module (using the same syntax as used in procedures) or it can be supplied with a separate file having the same filename as the library file with an ASCII or Windows help file.

Modules allow component models to be developed with all of the capabilities provided in EES and saved for reuse. Modules are certainly the most powerful of the new features.

New Property Data Routines

The thermodynamic property data routines have been modified to allow calculation of the thermodynamic properties of zeotropic mixtures. In a zeotropic mixture, the temperature may change during a constant pressure phase change. Property data for refrigerants R404A, R407C and R410A are provided.

Built-in functions have been added to return the critical temperature, pressure and specific volume of all real fluids, including the mixtures.

An external procedure called JANAF has been developed to provide the specific heat, specific enthalpy, and specific entropy (3^{rd} law reference) of many substances, including intermediate combustion species, as a function of temperature.

Uncertainty Analysis

In many cases, an important quantity is calculated as a function of one or more variables that are directly measured, i.e., $Y = f(X_1, X_2, ...)$. The measured variables, X_1, X_2, etc. have a random variability which is referred to as its uncertainty. EES now has the capability to calculate how the uncertainties in the measured variables propagate into the uncertainty of the calculated quantity, Y. The method for determining this uncertainty propagation is described in NIST Technical Note 1297 (Taylor B.N. and Kuyatt, C.E., 1994) and in Kline and McClintock, Mech. Engr., V75, 1953.

After selecting the new Uncertainty Propagation command in the Calculate menu, EES will present two lists of variables. The calculated variable is selected from one list and the measured variable(s) are selected from the other. The absolute or relative (fraction of the measured value) uncertainties for each selected measured variable can then be entered. After the calculations are completed, EES will display an abbreviated Solution Window containing the values of the calculated and measured variables and their respective uncertainties. The partial derivative of the calculated variable with respect to each measured variable will also be displayed. The new Uncertainty Propagation Table command allows the uncertainty propagation

calculations to be automated in a Parametric Table. The uncertainties of the measured and calculated variable are displayed in the Parametric table. Error bars showing the magnitude of the uncertainty can be displayed on plots of the calculated or measured variables. With these new commands, uncertainty propagation is EESy.

Complex Variables

EES can now solve equations involving complex variables. When configured in complex mode, every (non-string) EES variable is represented internally as two variables corresponding to the real and imaginary components of a complex number. Complex numbers can be entered in either rectangular or polar form. In rectangular form, the complex number is entered using the imaginary number operator (i or j) with a multiplication symbol (*) separating the imaginary number operator from variables or constants. A complex constant can be entered in polar form by providing the magnitude (also called absolute value) of the number and the angle entered in either degrees or radians. Each complex variable in the Solution Window can be displayed in rectangular or polar format. There are a number of new built-in functions that operate only in complex number mode, e.g., REAL, IMAG, CIS, MAGNITUDE, ANGLE, CONJ and others. In addition, most of the existing built-in functions have been adapted to operate in complex mode.

Multiple Sets of Default Variable Information

The Default Variable Information command in the Options menu allows the guess values, bounds, display format and units for variables to be automatically set based on the first letter of the variable. It is now possible to have multiple sets of Default Variable Information by using the Load and Store buttons that have been added to this dialog window. The Store button will save the currently defined defaults in a file having a .dvi filename extension. The Load button will load a previously-stored file and apply the defaults to all existing and new variables. The EES_DFLT.dvi file contains the variable defaults EES will apply when it is started.

Textbook Menu

EES can display a user-defined Textbook menu in the menu bar to the right of the Help menu. The textbook menu provides convenient access to a set of EES problems, such as those associated with a textbook.

Conveniences

The number of allowable variables has been increased from 2500 to 6000.

The number of allowable plot windows has been increased from 5 to 10.

Text items and lines/arrows on the plot windows can now be cut, copied, and pasted from one plot to another.

It is now possible to display gridlines on plots at positions between the axis numbers.

The column widths in the Parametric, Lookup, and Arrays tables may now be individually changed. Individual columns may be highlighted with a background color. Changes in the order of the columns in the Arrays window is supported.

The Print command now allows the option of printing multiple copies.

The psychrometric chart produced by the Property Plot command now allows the user to enter a range of temperatures on the abscissa.

Great news for Europeans! EES is now able to represent numerical values using a comma rather than a decimal point as the decimal separator. This capability is controlled by the decimal separator choice in the Windows Control Panel Regional Setting dialog.

EES will automatically load the HELLO.EES file if it finds this file in the EES main directory. We use the HELLO file to list new features. You can place messages, directions, or any information you wish in this file or you can delete it.

Lines and arrows can now be placed on the Diagram window. A bullet line type is now provided in addition to arrows and plain lines for the Plot and Diagram windows.

The height and width of the Variable Info dialog

can be changed by 'dragging' an edge of the window to its new size.
Three new directives have been added: $Warnings On/Off controls the setting of the Warnings Option in the Preferences dialog. $Arrays On/Off controls whether arrays variables are displayed in a separate Arrays table. $Complex On/Off controls the complex mode capability

The Lookup, Interpolate, and Differentiate functions will now accept an ASCII Lookup file, in addition to the binary .LKT file that was accepted in previous versions.

New Dynamic Link Library Files

One of the most powerful features of EES is its ability to interact with external programs. Two external programs of considerable interest are REFPROP 6 and AWMIX. REFPROP 6 is a highly-accurate database of thermodynamic and transport properties for refrigerants and refrigerant mixtures developed and distributed by the U.S. National Institute of Standards (NIST). For additional information contact:

Standard Reference Data Program
NIST Bldg. 820 / Rm. 113
Gaithersburg, MD 20899-0001
(301) 975-2208 (VOICE)/(301) 926-0416 (FAX)
srdata@nist.gov (E-MAIL)
http://www.nist.gov/srd/refprop.htm

An interface program that allows EES to obtain property data from REFPROP 6 has been developed and is available from F-Chart Software.

A new correlation of the thermodynamic properties of water/ammonia mixtures has been developed by R. Tillner-Roth and D.G. Friend which appeared in the J. Phys. Chem. Ref. Data, Vol. 27 No. 1 (1998). This correlation will also be available as an external FDL-library called AWMIX within the next few months. For more information contact:

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E-mail: kfroth@c36.uni-hannover.de.

Did You Know?

EES now allows up to 6000 variables in a program. However, an insufficient memory space error message can occur in programs using less than 6000 variables because EES automatically saves every variable that you enter whether or not you use it. For example, suppose you create array X with 1000 elements as follows.

```
Duplicate I=1,1000
   X[I]=I
End
```

EES allocates and saves the 1000 variables when you execute the program. If you then decide that you would rather use XX instead of X as the array variable name, EES will allocate and save an additional 1000 variables when you execute the program. You can force EES to eliminate the variables that are no longer in use as follows. First, change the array sizes so the problem can be executed without error messages. Then use the Save As command to save the problem file with a different name. Hold the Ctrl key down while saving the file. Depressing the Ctrl key will force EES to save only the variables that are referenced in the Equations Window. When you reopen this file, you will recover the variable space that was allocated for unused variables.

Pressing the Ctrl key while opening a file will prevent EES from automatically compiling and formatting the equations in that file.

FEHT - Finite Element Analysis

F-Chart Software distributes another program which may be of interest to you. FEHT (pronounced 'feet') provides finite element numerical solutions of steady-state and transient two-dimensional problems in heat transfer, bioheat transfer, potential flow, steady electric currents, electrostatics, and scalar magnetostatics. Versions of the program are available for

all Windows operating systems and for the Apple Macintosh series computers. Academic and site licenses are available.