EESy Solutions

ⓜⓜⓜ

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. Our intent is to publish the newsletter twice yearly. We encourage user contributions so send us your comments and questions.

What's New?

The big news for this issue is the release of the new versions of EES for the Mac and PC. Also, there is now a 32-bit version of EES for the PC (see below). A short description of some of the features added within the last year is provided below. Many of the new features were suggested by users. Let us know if you have a suggestion for improving EES.

Unit Conversion
EES now provides unit conversion with its new Convert function. This function takes two string parameters and returns the conversion factor to convert from the units represented by the first string to that represented by the second. A large set of unit definitions have been included and additional units can be entered by the user. As an example, the following equation would convert 5 Btu/hr-ft^2-F into its equivalent in W/m^2-K

   h = 5 * Convert(Btu/hr-ft2-F, W/m2-K)

Interpolate and Differentiate
Functions have been added to provide linear, quadratic, and cubic interpolation as well as numerical differentiation of tabular data in the Lookup Table, Lookup files, and the Parametric Table. The Interpolate function combines the capabilities of the existing Lookup and LookupRow functions and greatly simplifies use of tabular data.

Automatic Variable Format
A new automatic display format has been added to the existing fixed decimal and exponential formats. Automatic formatting selects the format type (fixed decimal or exponential) and the number of significant figures based on the value of the variable. Automatic formatting is now the default and in most cases, it eliminates the need for user to select an appropriate display format.

Equation-Based Integrals
Earlier versions of EES could only apply the Integral command in conjunction with the Parametric table. The Integral command has been expanded to include a form in which the initial and final values of the integration variable and (optionally) the step size can be specified. For example,

G=INTEGRAL(X^2,X,0,1,0.05)

would return the integral of X^2 with respect to X integrated for values of X between 0 and 1.0 with a fixed step of 0.05. If the step size is not provided, EES will automatically choose a variable step size to maintain a reasonable level of accuracy. The integrand can be any EES expression so that implicit functions of the integration variable can be easily accommodated.

Improvements to the Solution Window
In earlier EES versions, clicking on a variable in the Solution window would bring up a dialog window in which you could enter/modify the units and display format for that variable. In the new version, you select on one or more variables by clicking on them. Double-clicking (or pressing the Enter key) will bring up the dialog window which allows the units and display format for all selected variables to be changed. In the PC version, the selected variables can now be copied to the clipboard as a picture (as well as ASCII text) so that they can then be pasted into another application such as a word processor just

as they appear in the EES Solution window.

Saved File Indicator
You type information into EES and you should periodically save your file. Did you save it? EES saves the files so quickly, you may not even notice the blink of your hard disk light. Or perhaps you are working on a network so you can't see the hard disk light. Well, this is no longer a problem, since EES puts a check mark indicator next to the Save command in the File menu when the file has been saved. The indicator is removed if any changes are made.

DEBUG Window (PC version)
Consider the following situation. You have a complex problem which requires 84 equations. You enter them into EES and select the Solve command. But EES reports that the you have 86 variables and 84 equations. Perhaps you mistyped some of the variables. Or maybe you forgot some equations. The DEBUG window in EES now gives you very specific information indicating what variables are likely to be involved in the missing equations. If you have overdefined the problem, EES will indicate which equations are not needed. The Residuals window can now be displayed even if the equations cannot be solved so that you can see how the equations are ordered by the EES solver.

Formatting Options
The Formatted Equations and Solution, windows optionally allow variables to be displayed in an enhanced format. For example, alpha will display as α and X[5] will display as X_5. Several new formatting options are now available. Appending _dot or _bar to a variable name will display that variable with a dot or bar, respectively centered over the variable name. Formatted variables (and units) are now displayed in the headers of the Parametric and Arrays windows. In the PC version, equations and comments in the Formatted equations window can be moved to other locations on this window, so you make the window appear as you please. The formatted equations and comments can be individually selected and copied to the clipboard so that they can then be pasted into another application.

$INCLUDE Directive (PC only)
The functionality of the $INCLUDE has been expanded. This directive can now be used to load internal or external library files, in addition to files of equations.

Make Distributable Program (PC only)
An option has been provided to create a special purpose version of EES which will run one to five preselected problems. EES, the problems, and all supporting files are placed in one executable file. This file can be distributed to others so that they can run your EES programs; even if they do not own EES!

Other Features
There are many other new features, but we're out of space. In addition, there have been literally hundreds of small changes for both the Mac and PC versions to make EES operate more reliably and predictably.

EES 32

The version of EES we have been (and still are) distributing for the PC is a 16-bit program which operates under all Windows operating systems. However, we have now developed a 32-bit version of EES called EES32 which we are distributing as an extra-cost option. EES32 only operates under Windows 95 and NT. It will not run with Windows 3.1. EES32 is identical to the 16-bit program in all respects except one; it does the calculations faster - much faster, depending on your computer equipment. On a computer equipped with a Pentium Pro processor, EES32 can do the calculations up to 5 times faster than the 16-bit version for computationally intensive problems. In addition, EES32 can link to 32-bit external libraries (DLLs). If speed is an issue or if you are planning to develop external library files for EES, you should consider ordering the 32-bit version.

EES Short Courses

Two short courses involving EES will be given this summer, one at University of Wisconsin - Madison and the other at Purdue University and

The Wisconsin course is entitled ***New Methods in HVAC and Energy Analysis Calculations*** offered on July 28 to July 31 in Madison. This course, which has been offered for three years, shows how EES can be effectively used to solve complex HVAC, refrigeration, and energy analysis problems. The course is appropriate to all levels of EES users. Contact Mary Danielson at (608)-263-3161 for more information.

The Purdue short course is entitled ***Modeling and Design of Vapor Compression Systems with An Emphasis on Refrigerant Mixtures***. A major objective of this course is to identify the effects of refrigerant mixtures on refrigeration system design and performance. This course will use EES with the REFPROP refrigerant properties program developed at the National Institute of Standards and Technology. Contact Cynthia Quillen at (765) 494-6078 for more information.

Ammonia-Water Properties

Ammonia-water property data have been distributed with EES in the NH3H2O external library for several years. The property routines in the NH3H2O library use the correlation described by Ibrahim and Klein in a paper entitled "Thermodynamic Properties of Ammonia-Water Mixtures" which appeared in ASHRAE Transactions, Paper CH-93-21 in January, 1993. In our opinion, this was the best available correlation for ammonia-water mixtures, but now there is something better. A new correlation has been developed by Reiner Tillner-Roth and Dan Friend at the National Institute of Standards and Technology. This correlation has been formulated into an EES external library program

called AWMix©. It provides reliable information on the thermodynamic properties of ammonia-water for the entire composition range and in a wide range of temperature and pressure. Specifically, the AWMIX library program provides property data for all compositions from pure water to pure ammonia, VLE-properties between the solid-liquid-vapor boundary (195.5 K to 273.16 K) and the critical locus (405 K to 647 K), properties of liquid and vapor up to 40 MPa and good predictions in the supercritical range. The AWMIX library can be ordered from F-Chart Software for $250. It will be available August 1, 1997.

Refrigerant Property Data - REFPROP

EES provides accurate properties for many pure refrigerants, including some of the new refrigerants such as R134a, R125, and R143a. However, a number of the promising refrigerant alternatives in use or under consideration are blends of two or more components, e.g., R407c and R410a. Although EES does not directly provide properties for refrigerant blends, these properties can be accessed by EES from REFPROP, the National Institute of Standards and Technology (NIST) refrigerant properties database program.

REFPROP versions 4 and 5 and an interface program allowing EES to connect to these programs has been available for several years. A new version of REFPROP (called REFPROP 6) has been under development at NIST for the past two years and it should be released this summer. This new version provides high accuracy formulation for all pure refrigerants and the most advanced methods for estimating the properties of mixtures. An interface has been developed for REFPROP 6, combining the NIST property data base with the equation-solving and other features of the EES program. If you are involved in modeling refrigeration systems, you will find the NIST REFPROP 6 program and the EES/REFPROP 6 interface to be of considerable

interest. The EES/REFPROP 6 interface is $1000. Contact F-Chart Software for additional information.

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, bio-heat transfer, potential flow, steady electric currents, electrostatics, and scalar magnetostatics. Versions of the program are available for the Windows operating systems and for the Apple Macintosh series computers.

FEHT provides three essential functions: Problem Definition, Calculations, and Output. The Problem Definition commands provide a drawing environment in which the mouse is used to draw the outlines of the one or more materials. A variety of drawing aids are provided. Triangular elements of arbitrary size needed in the finite element analysis are formed simply by clicking the mouse button on the endpoints of the lines. Once a course triangular mesh is prepared, an automatic mesh command can be used to reduce the mesh size. The Problem Definition is completed by specifying the boundary and initial conditions (for transient problems). These specifications are made by tagging the line, node, or material with a mouse click (causing it to flash) and then selecting the desired specification from a pull-down menu. All properties and boundary conditions may be entered as a function of position, time, and potential.

Calculations are initiated from a pull-down menu. The program first checks to see that all materials are properly discretized and the properties, boundary, and initial conditions are specified. For transient problems, the computational method (Euler or Crank-Nicolson) and start, stop and time step are entered in a dialog window at the start of the calculations.

A variety of output capabilities are provided. For steady-state problems, the potential (e.g., temperatures, voltages, etc.) within the material may be shown at the nodal positions or as a contour plot. The potential at the cursor position is displayed when the mouse button is depressed. The flux (e.g., heat flux, current density, etc.) at the center of each element can be displayed by an arrow pointing in the direction of the flux with the shaft length proportional to the flux magnitude. The flow (heat flow, charge, etc.) across any line or set of lines may be displayed. For transient heat transfer problems, the temperatures of from one to six nodes may be displayed in a temperature versus time plot. Heat flow can be plotted as a function of time. The contours or heat fluxes for each time step may be shown in sequence providing a 'movie' depicting the changes with time.

Did You Know?

The Variable Information dialog window has a number of very useful capabilities that many users are unaware of. For example...

The first column in the dialog window displays the name of the variables in your equations, listed alphabetically. You can change one or more variables names if you wish. When you exit from this Variable Information dialog window, EES will (after confirmation) change the variable name everywhere it appears in the Equations and Parametric window. This capability is much more convenient than the Find/Replace option and eliminates the need to recreate the Parametric table when a variable name is changed.

The guess value field in the Variable Information dialog can accept an existing variable name in place of a numerical value. EES will use the current value of the variable specified as the guess when solving for the value of the variable.

Clicking in the display format column will bring up a pop-up menu shown showing the formatting

options (Auto, Fixed, Exponential). If you hold the Ctrl key (PC version) or Option key (Mac version) down while selecting a formatting option, that formatting option will be applied to all variables below the one you are changing. This capability makes it easy to change all variables to new Auto format display option.
.