

# EESy Solutions

Engineering Equation Solver Newsletter

No. 14, Spring 2004

## 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](http://www.fchart.com).

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## Instant Update Service

All new licenses of EES are provided with one year of Instant Update Service. Instant Update Service is a valuable addition to EES, since it is updated frequently. The latest version is placed on our server so that subscribers can download a new version whenever they wish to do so. If your current version of EES is 6.907 or newer, 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 25% of current cost of the program per year. Contact F-Chart Software or use the web ([fchart.com](http://fchart.com)) if you wish to subscribe to Instant Update Service and take advantage of some of the new features described below.

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## Academic Professional Site Licenses

The Professional version of EES provides a number of important capabilities. Among the most popular are the ability to create animations that are controlled by equations and the ability to create stand-alone distributable programs. The Professional version provides access to the genetic optimization algorithm and allows larger problems to be solved. This issue of EESy Solutions will provide information on some of these capabilities. Up until recently, the Professional version was not available as a site license to academic departments. This policy has been changed. The Academic/Professional is available for a one-time fee of \$3,750. Departments that currently have an Academic license receive a \$1,000 credit.

F-Chart Software  
<http://www.fChart.com>

## 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.

### Diagram and Plot Window Animations

The Professional version of EES provides powerful capabilities to animate drawings and plots in the Diagram and Plot windows. Unlike many other animation programs that provide capability to create animated drawings, EES allows the animation to be controlled by calculated values. The animation in the Diagram window can thus be accurately displayed. In addition the movements of objects in the Diagram window can be directly coupled to animations in the plots. Animations can only be created by the Professional version, but once created, they can be displayed in any version of EES, including academic versions and distributable programs. Animation capability adds a new dimension to EES. We recommend that you run some of the examples provided in the Animations menu item of the Examples menu to appreciate the power of this new capability. Animations are also very easy to create, as shown by example in this issue.

### Improvements to the Optimization Capabilities

The most powerful new addition to the computational capabilities in EES this year is the genetic optimization provided in the Professional version. The genetic optimization algorithm is designed to reliably locate a global optimum even in the presence of local optima. The robustness of all of the optimization algorithms has been increased by providing an option to continue calculations, even if an error condition is encountered. Another option that has been added is the ability to log results to a disk file so that the progress of the optimization process can be recorded. The progress dialog that appears during optimization calculations displays both the current and the best values of the independent variables

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The genetic method mimics the processes occurring in biological evolution. A population of individuals (i.e., sample points) is initially chosen at random from the range specified by the bounds of the independent variables. The individuals in this population are surveyed to determine their fitness (i.e., the values of the objective function as quantified by the value of the variable that is to be minimized or maximized). Then a new generation of individuals is generated in a stochastic manner by 'breeding' selected members of the current population. The characteristics of an individual that are passed on to the next generation are represented by encoded values of its independent variables. The probability that an individual in the current population will be selected for breeding the next generation is an increasing function of its fitness. The 'breeding' combines the characteristics of two parents in a stochastic manner. Additional random variations are introduced by the possibility of 'mutations' for which the offspring may have characteristics that differ markedly from those of the parents. The current implementation allows the user to control the number of individuals in the population, the number of generations, and the maximum mutation rate.

#### Property Data

A distinguishing feature of the EES program is its extensive library of fluid property data that is coupled with its equation solving capability. New property functions, P\_sat and T\_sat return the saturation pressure and temperature, respectively, of a fluid without having to specify a quality. The Enthalpy\_Fusion function returns the enthalpy change of fusion for the specified substance at its normal melting temperature. Thermodynamic and transport property data have been added for R116, R124, Krypton, SF6, R143a, n-heptane, n-octane, FC72, and Xenon.

#### 3D Plotting Capability

3D plotting capability was originally implemented in version 6.394. It was removed in version 6.648 because some video drivers are not able to function properly with the 3D plotting routines. The current version allows EES to be installed with or without the 3D plotting capability by checking the appropriate option in the installation program.

#### Conditional Compilation

The \$IF/IFNOT directives allow conditional inclusion of equations in the Equations window, eliminating the need to comment and uncomment equations for different situations. This capability, introduced in version 6.685, has been extended to include tests for the presence of the Diagram window and Integral Table. The \$IF/IFNOT directives know whether the solution was started by the Solve, Solve Table, or Min/Max Table commands and the equations can be automatically changed for each situation. \$IF/IFNOT can also test a string variable and change the equations that are to be solved based on the contents of the string variable. The string variable can be set with a drop-down selection box in the Diagram window. Examples of this powerful capability can be found in the Directives menu option of the Help menu.

#### Solving Selected Parametric Tables

There is no limit on the number of Parametric tables that can be defined, other than available memory. EES formerly allowed a selected table or all tables to be solved. Starting in version 7.093, the tables that are to be solved with the Solve Table command can be selected.

#### Setting Global Constants

Constants in EES are identified by a variable name that ends with #. The distinguishing characteristics of constants is that they have a value and associated units in both the English and SI unit system and they are directly accessible to the main program and all subprograms, functions, and procedures. EES is shipped with a number of predefined constants, such as the g#, for gravitational acceleration. Additional constants are entered by the user with the Constants menu item in the Options menu. However, constants entered in that manner are permanently stored. The \$Constants directive allows constants to be defined just for the currently defined problem. Since constants are visible to all EES functions, procedures, modules, and subprograms, constants defined with the \$CONSTANT directive serve as global variables within an EES file. These constants are useful for specifying the size of arrays that are passed to EES functions and procedures.

### Macro Command Additions

The macro command capability in the Professional version provides an easy way to repeat a series of instructions. Clicking the Play button in the Macro command window will replay all of the commands that are displayed. If a Cycle command is included in the macro file, the commands in the macro file are repeated for a specified number of times or indefinitely, if no specification is provided. Pressing the Esc key will stop execution. A Pause command can be included in the macro file so that EES will pause for a specified time period between each execution of the macro commands. With these commands, it is possible to interface EES to a data acquisition program that outputs data to a file or to the Clipboard at specified time intervals. EES can repeat its calculations with each new set of data placed in the file or on the clipboard.

### Saving Tables

The Save Lookup Table command in the Tables menu has been removed. In its place is the Save Table command that allows all EES tables (including the Arrays and Integral Tables) to be saved in a choice of formats. This command provides a convenient way to export data to EES Lookup tables or to other applications. An option to transpose rows and columns is also provided.

### Peng-Robinson Support Routines

The Peng-Robinson equation of state cannot provide the high accuracy thermodynamic property information available with the EES built-in property relations. However, the Peng-Robinson routines provide a means of estimating the thermodynamics properties of fluid mixtures. A set of support routines that provide compressibility and fugacity factors, for liquid and vapor phases, as well as enthalpy and entropy departure information are implemented in the Peng-Robinson.DLL external library.

### Copying Tables with Header Information

The Copy Table with Headers menu item in the Edit menu copies the column name and units, in addition to the selected data, to the clipboard.

### Making Distributable Programs

The Make Distributable command (File menu, Professional version) has been modified to allow up to 100 files to be included with a Distributable program. The files are accessed from a Distributable Files menu that is placed at the rightmost position of the menu bar. The name of this menu can be supplied when the distributable program is created. Horizontal menu separators can be added by supply a hyphen (-) as the file name. Provisions have been added to the Make Distributable command to view and reorder the files that are to be included in the distributable program. The contents of a .jpg, .wmf, or .bmp graphical file can optionally be displayed when a distributable program is started. This file can be used to provide author information, a company logo, or any desired information. The contents of the file are incorporated into the distributable when it is created. The Make Distributable command provides a check list of external files that should be included with the Distributable program and a ..\UserLib subdirectory is automatically created if needed. Also check boxes are now available to control access to the Calculate menu, and the Solution, Residuals, Arrays, and Integral Table menu items for each EES files included in the Distributable program. The Constants.txt file is now saved with the Distributable program. It is no longer necessary to provide it separately.

### Conveniences

A Paste Special button is has been placed in the upper left cell of the Lookup Tables. This button allows column names and units to be pasted from the clipboard, in addition to data in the table.

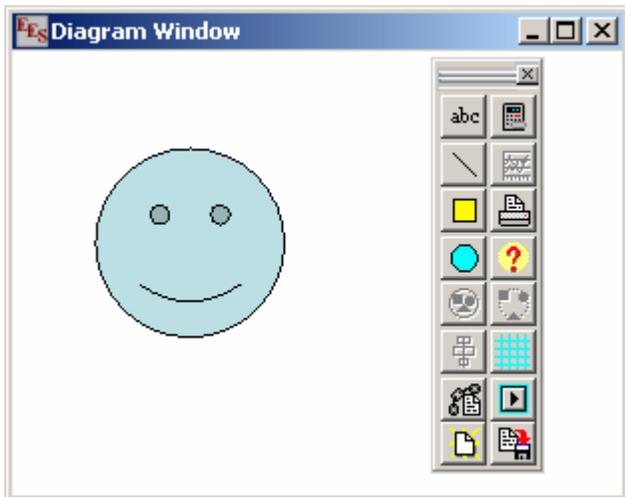
A Sort button is provided in the upper left corner of the Arrays Table. Clicking the Sort button will arrange the columns in the Arrays Table into alphabetical order.

A column in any of the tables can be moved to a new position by dragging its header cell (top row) with the left mouse button to a new location.

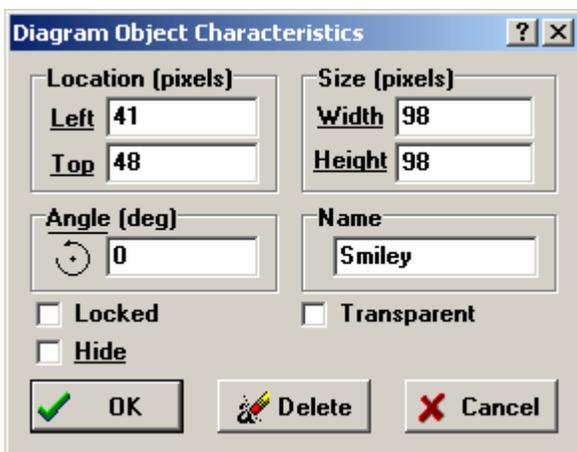
### Tips and Tricks

The animation capability provided in the Professional version is powerful and easy to use. Follow the instructions below to create an animation.

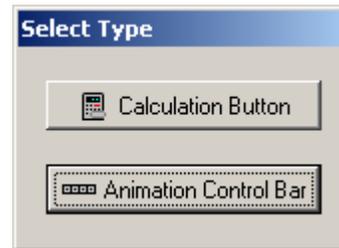
Create a graphical object in the Diagram window using the EES drawing tools (accessed from the Diagram window toolbar) or by pasting an object drawn in another program, e.g., PowerPoint. The latter method is used here.



Right-click on the smiley face object and select the Properties menu item from the pop-up menu.



Enter a name, e.g., Smiley, for the object. The attributes of Smiley can now be specified in the EES Equations window. Click the Add Calculate Button at the top right of the toolbar and select Animation Control bar.



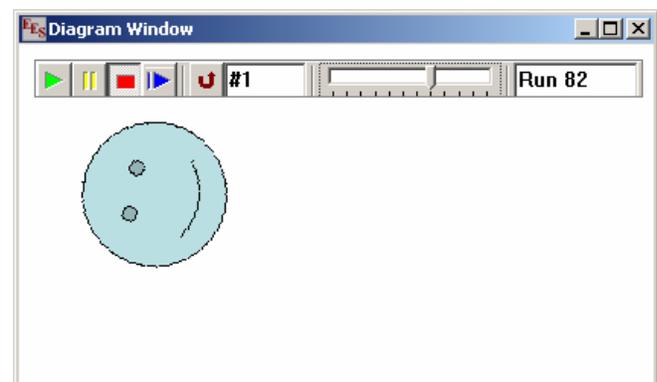
Right click on the animation control bar and select the Solve Table button. Hide the Diagram toolbar to put the Diagram window in application mode.

Enter the following equation into the Equations window.

Smiley.angle=theta

Create a Parametric table with 361 rows and include variables Smiley.angle and theta. Fill the theta column with numbers between 0 and 360 by clicking on the triangular control at the upper right of the theta column in the Parametric table.

Bring the Diagram window to the front and click on the green triangular play button in the animation control bar. Smiley should now be turning.



Congratulations! You have just created an EES animation. Hide the Parametric table if you do not wish to see it being updated. Try some of the controls in the animation control bar. The buttons allow you to pause, stop, re-start. The loop button will keep the animation going until you stop it with the Esc key. The speed can be controlled by the slider bar. Its fun and EESy.