F-Chart Software

No. 24, Summer 2013

EESy Solutions

Engineering Equation Solver Newsletter

Inside this issue:

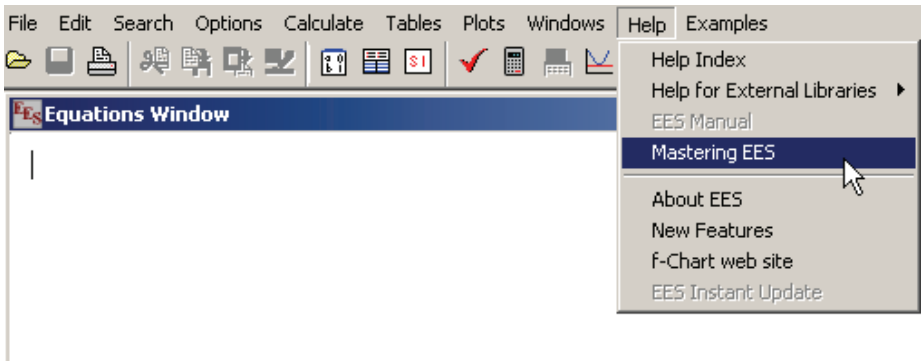
Welcome

This is the 24th issue of EESy Solutions, a newsletter that is developed to provide news, tips, and other updates to users of the Engineering Equation Solver software. EES has been a commercial software for more than two decades. If you have missed any of the previous issues of EESy Solutions they can be downloaded from http://fchart.com.

Mastering EES is live...

The book *Mastering EES* has been published by F-Chart Software The book provides a comprehensive presentation of all of the features of the Commercial and Professional versions of EES complete with many examples. Because it is a downloadable book (from fchart.com) it is constantly being updated as features are added to EES.

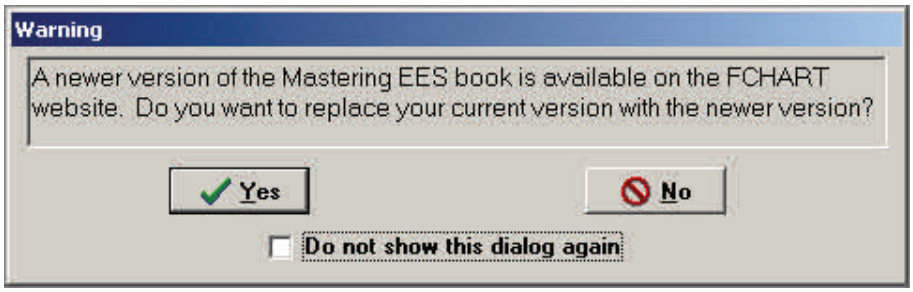
In EES versions 9.373 and newer, Mastering EES will automatically open when the Mastering EES menu item is selected from the Help menu, provided that the Mastering EES.pdf file has been installed in the EES directory.

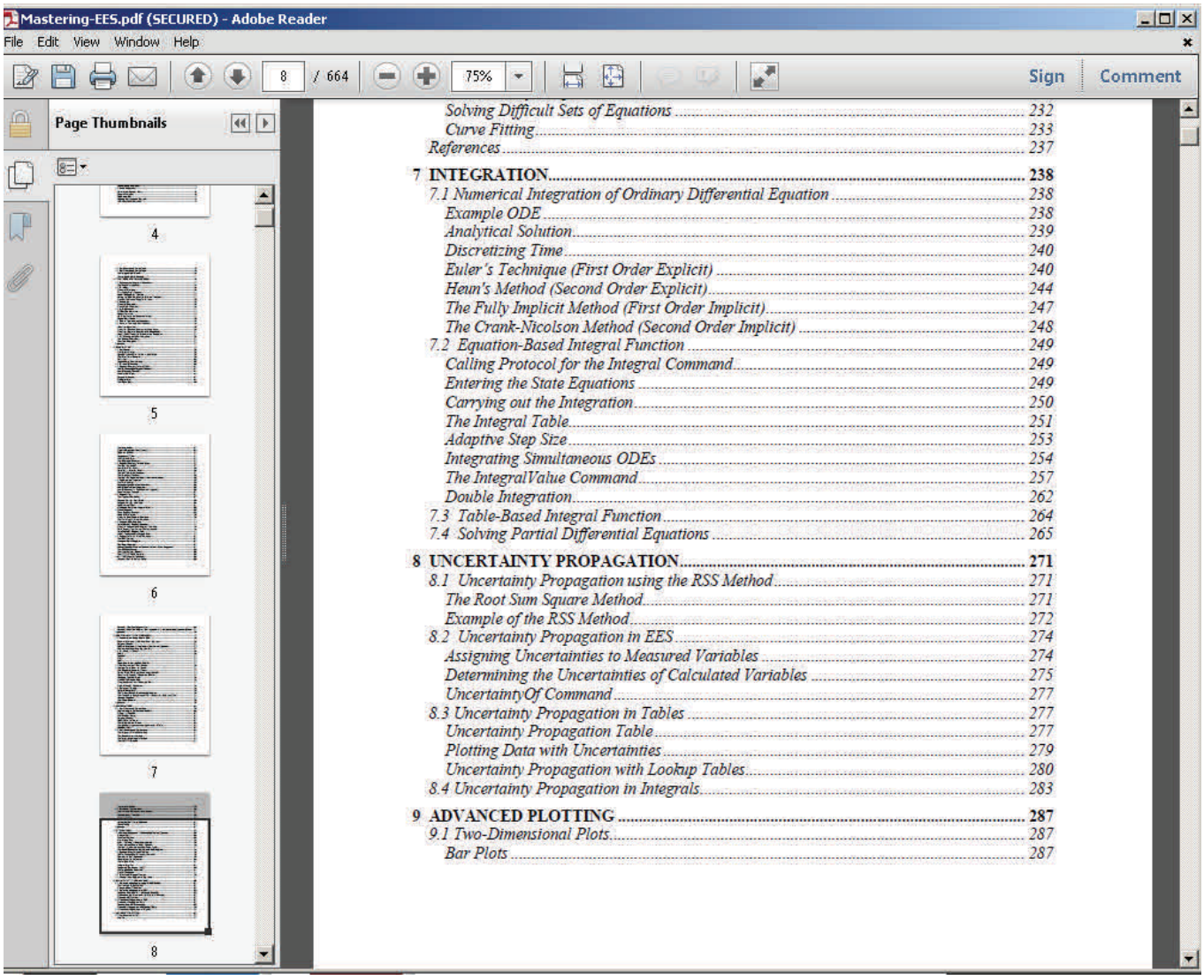


Mastering EES is live...

If a newer version of Mastering EES is available, it will automatically be downloaded from the fchart.com website and installed.

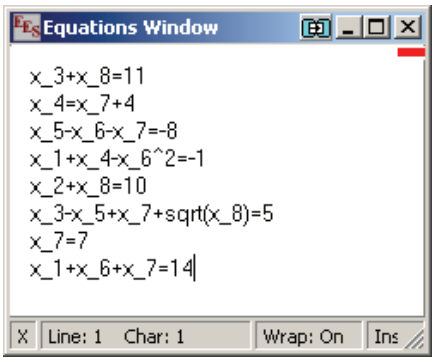
The pdf file will be opened and the password automatically entered. The fully linked table of contents can be used to easily navigate the more than 650 page book



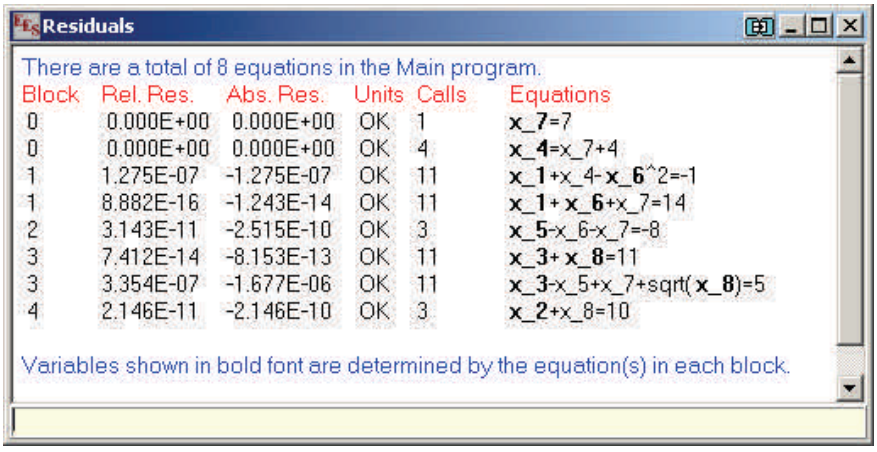


Computational Flow Window

The Residuals window provides information about how EES solves a set of equations. It is useful for debugging problems and isolating convergence issues, as well as understanding how the equations are solved.

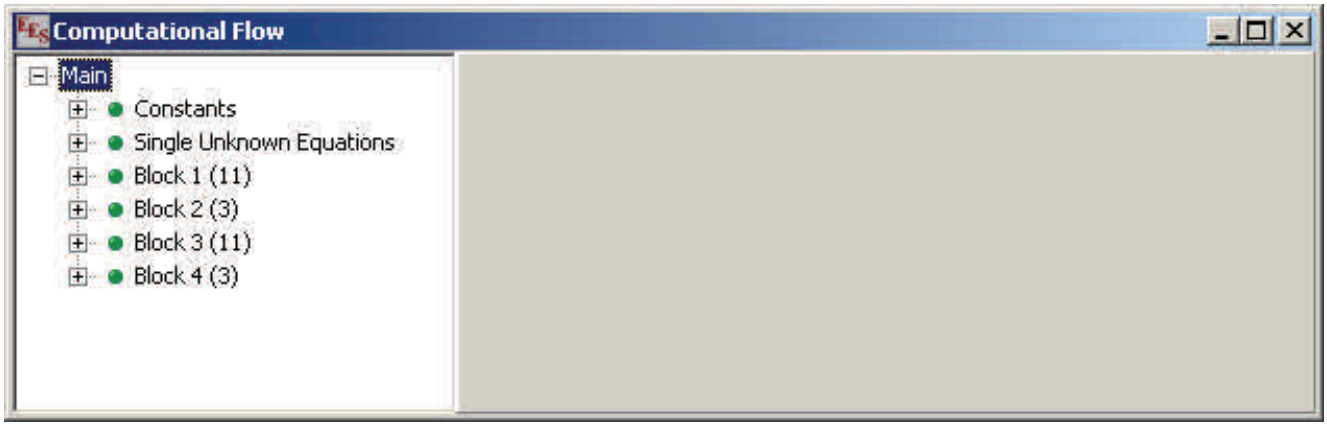


For example, consider the equation set shown here. The Residuals window provides information regarding how these equations are blocked (i.e., separated into smaller sets that can be solved more easily) as well the convergence associated with each equation and the number of times it was called.



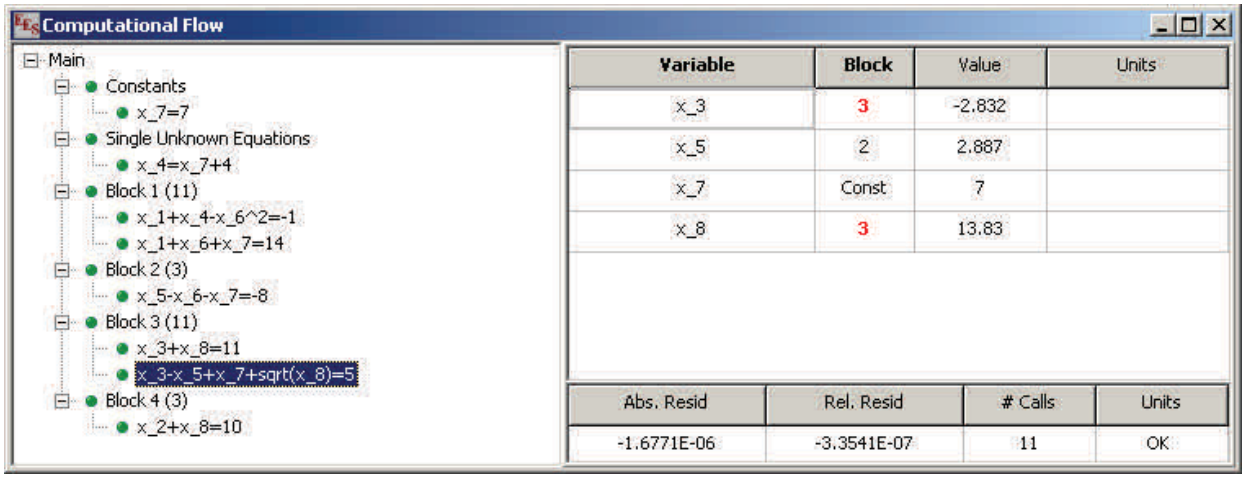
In the Professional version of EES, the Residuals window has been replaced by the Computational Flow window for versions 9.310 and later. The Computational Flow window is an expanded and improved version of the Residuals window that can be accessed by selecting Computational Flow from the Windows menu. (Note that holding down the Ctrl key during the selection will provide the original Residuals window).

In the Computational Flow window, the pane on the left illustrates the organization of the equations. Constants are equations that assign a numerical value to a variable. Single Unknown Equations are equations that involve only one equation and one unknown (note that variables set to constants are not considered unknowns). The remaining equations are placed in blocks that are solved sequentially. The number in parentheses beside each block indicates the number of iterations required to solve that block during the solution process. A similar tree structure would be shown for equations in each Subprogram.



Computational Flow Window

Right-click on the + sign beside the Main tab and select Show All Equations in order to view all of the equations in every block (see below). Selecting the + sign beside any block will expand the equations in that block.



Selecting a block will show all of the variables in that block in the right pane. Selecting a single equation will restrict the right pane to only the variables for that equation. The figure above shows the second equation in Block 3 selected and contains information about the four variables involved in that equation. This information includes the latest value and units for each variable. In addition, the "source" of each variable (i.e., the place where its value is determined) is shown in the Block column. A red number indicates that the variable is determined in the current block (e.g,, the variables x_3 and x_8 are solved in the current block, Block 3). A black number indicates the lower block where the variable was obtained (e.g., x_5 was solved for in Block 2 before entering Block 3). Other keywords that can be placed in the Block column are listed in the table below. The pane at the bottom right indicates the absolute and relative residual associated with the equation. The unit checking status and number of times that the equation was called are also indicated. The Find command can be used to locate any variable.

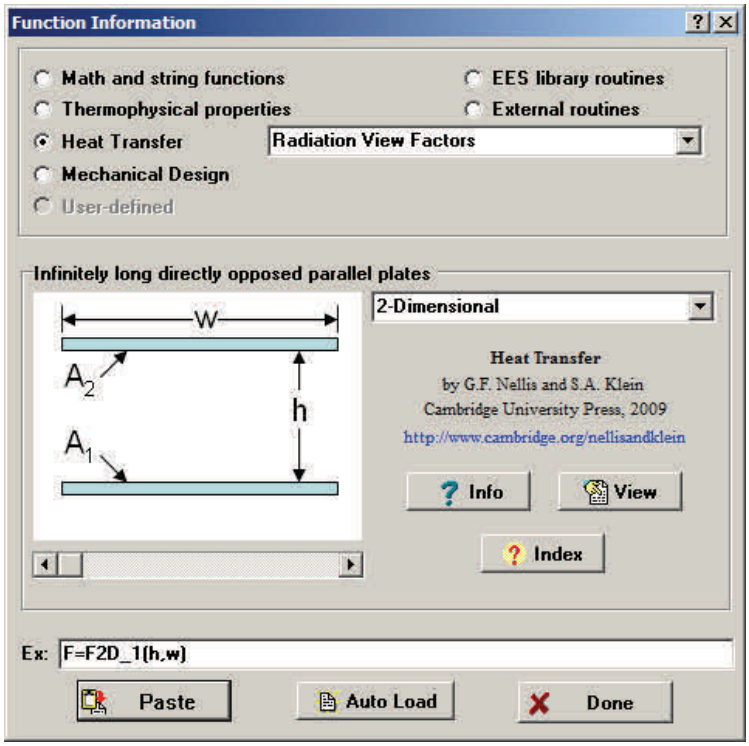
Keyword	Source of variable
Const	The variable is a constant that is defined in the Equations window.
Single	The variable is determined by solving a single equation in which it is the only unknown.
Integral	The variable is defined by EES as it is the integration variable in an equation-based integral.
Macro	The variable is defined in a Macro file or in the Macro Command window.
Import	The variable is defined using a $Import directive.
Table	The variable is defined in a Parametric table.
MinMax	The variable is one of the independent variables set by the optimizer in EES.
Common	The variable is defined by a $Common directive.
Diagram	The variable is defined in a Diagram window (either the main window or a child window).
VarInfo	The variable is created by EES and used in an equation for guess values or limits in the Variable Information dialog.
Input	The variable is an input (for a Subprogram or Module).

The View Factor Library

The Heat Transfer Library is an extensive selection of functions and procedures that have been developed to help solve problems related to heat transfer. The library was created during the development of the text book *Heat Transfer* by Nellis and Klein (http://www.cambridge.org/us/Nellis_Klein/) and continues to grow and expand.

Radiation calculations typically require view factors in order to capture the surface-to-surface interactions that occur. View factors can be obtained directly by solving the complex view factor double integral or by using the stochastic Monte Carlo approach. However, often the view factor that is required can be obtained from an existing view factor library. Many of these view factor formulae have been programmed in EES and this number continues to grow.

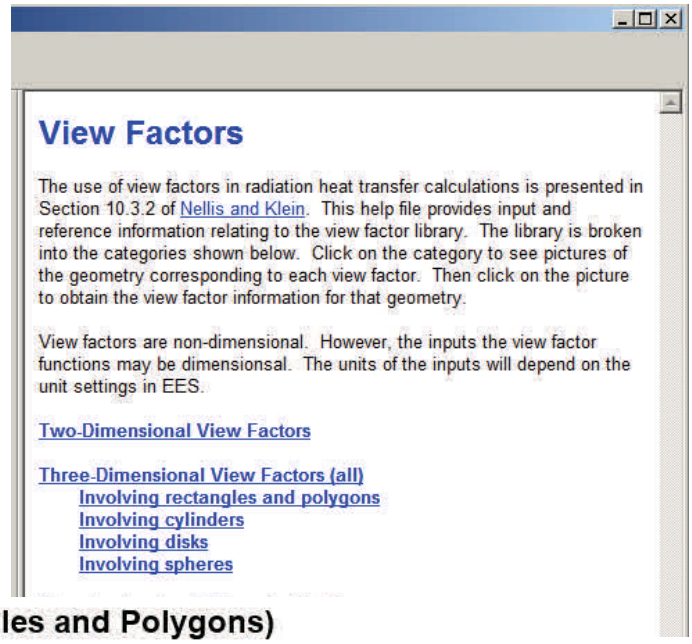
In order to access the view factor library, select Function Info from the Options menu and then select the Heat Transfer radio button. Select Radiation View Factors from the drop down menu.



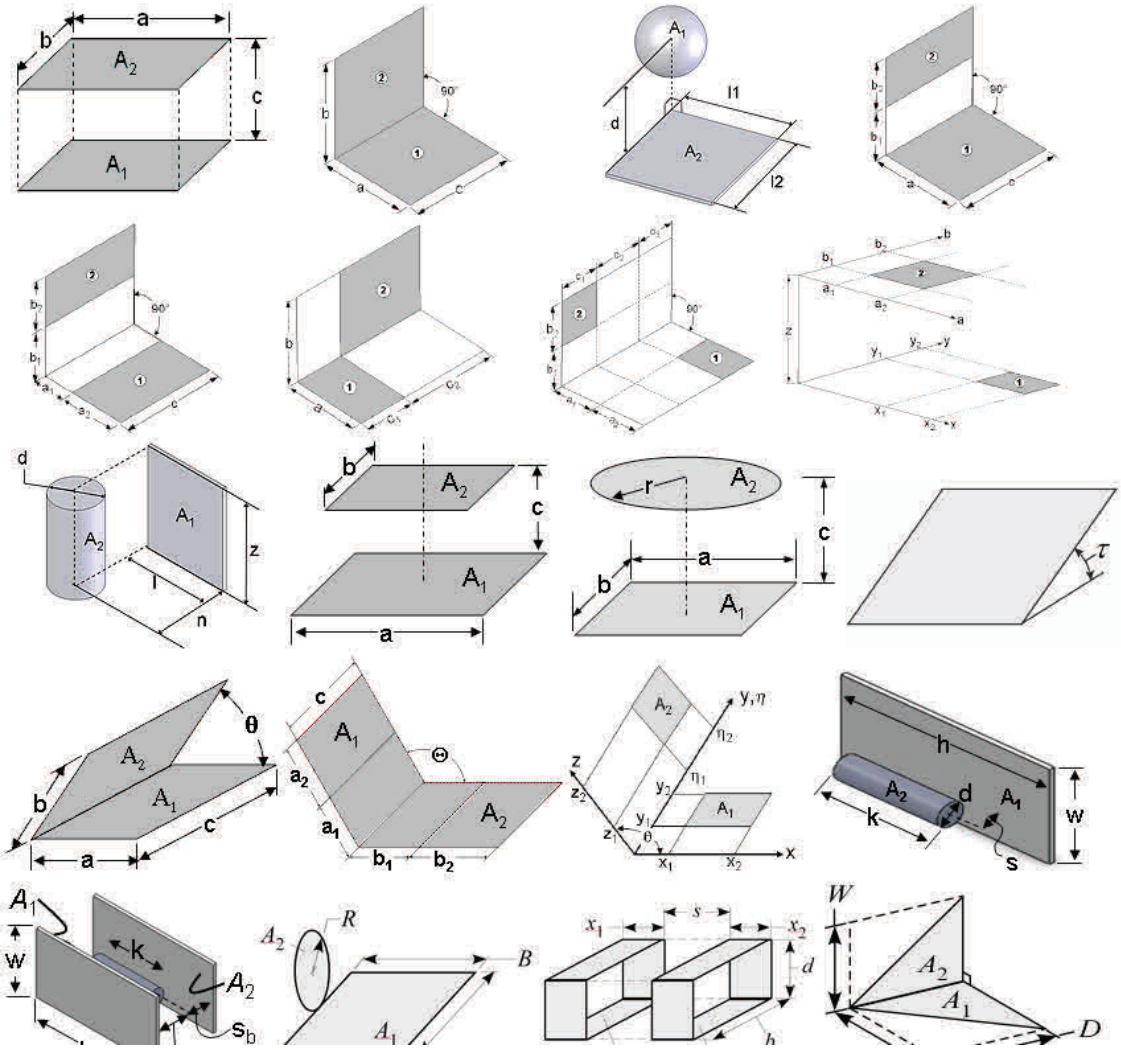
The View Factor Library

The view factors are divided into 2-Dimensional, 3-Dimensional, and Differential. Most of the effort has been put into developing the 3-Dimensional library as these view factors are the most useful. Select 3-Dimensional from the lower dropdown menu and then select Index to display the view factors that are available.

Note that the 3-Dimensional view factors are further subdivided based on the geometric shape that is involved (e.g., rectangles or cylinders). Select one of these categories in order to get a graphical display of the associated view factors.



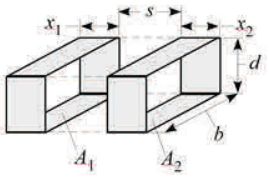
Three-Dimensional View Factors (Rectangles and Polygons)



The View Factor Library

Select any of the view factors from the index to obtain more information about the function. For example, the adjacent figure presents information for the function F3D_34. Note that the inputs are carefully defined using a figure and an example of the correct usage is included.

Interiors of aligned rectangular enclosures



Function F3D_34(x_1, x_2, s, b, d) returns the view factor from the internal surface of two aligned rectangular enclosures.

Inputs:
x_1 = width of enclosure 1 [m] or [ft]
x_2 = width of enclosure 2 [m] or [ft]
s = gap between enclosures [m] or [ft]
b and d = dimensions of the enclosure in directions perpendicular to the aligning axis

Example:
$UnitSystem SI Mass J K Pa
x_1=1 [m]
x_2=1 [m]
s=0.2 [m]
b=1 [m]
d=2 [m]
F=F3D_34(x_1,x_2,s,b,d)
{Solution: F=0.1294 }

Reference:
Stevenson, J.A. and Grafton, J.C., 1961,
"Radiation heat transfer analysis for space vehicles,"
Rept. SID-61-91, North American Aviation (AFASD TR 61-119, pt. 1), Sept. 9.

EES Training Opportunities

EES is used in many companies, organizations, and academic institutions. Most users are aware of the basic features—solving equations, Parametric Tables, plotting, and the powerful property routines. However, fewer users are aware of the more powerful features of EES such as optimization, integration, uncertainty propagation, complex algebra and subprograms. More advanced features available in the Professional version, such as the Diagram Window, animation, executables, directives, and macros, can enhance the capabilities of the program and open the door to a wide range of applications.

Our staff are available to provide a 1 day EES short course tailored to new users or experienced EES users. The cost is $1500 plus travel expenses. Contact Greg Nellis by email to arrange a training session (info@fchart.com).

EES Training Seminar

- Introduction to EES
- Thermodynamic and Transport Properties
- Functions and Procedures
- Curve Fitting and Interpolation
- Convergence and Debugging
- Optimization
- Integration
- Uncertainty Propagation
- Subprograms and Modules
- Libraries
- Heat Transfer Library
- Complex Algebra
- Directives
- The Diagram Window
- Animations
- Distributables
- Macros
- Communicating with other programs

Some Recent Changes to EES

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- High accuracy thermodynamic and transport property data have been implemented for R236fa, R407C, R410A, R404A, R507C, cis-2-butene, trans-2-butene, isohexane, neopentane, and several siloxanes,
- An alternate set of units can be selected for displaying variables in the Solution window. Right-click on the variable and enter the secondary unit in the (Units) field. Similar features have been added for the Parametric, Arrays, Lookup, and Integral Tables.
- Two new macro commands have been added to help open a series of files with the same extension using a macro. The GetFirstFile$ command returns a string containing the first file in the current directory with a specified extension. The GetNextFile$ command returns a string containing the next file with the given extension. These commands can be used to open and manipulate multiple .csv or other file types.
- EES will accept temperature change units. These units are indicated by DELTAF, DELTAC, DELTAR, and DELTAK.
- A plot thumbnail window is available in the Professional version. This window displays a thumbnail version of all of the plots in the EES file. It is accessed by selecting Plot Windows from the Windows menu and then selecting Plot Thumbnails.
- The Rename macro command allows files to be renamed.
- The number of independent variables that can be used in optimization problems has been increased to 80 in the Professional version.
- The maximum number of columns in a Lookup table has been increased to 1500. The number of rows is unlimited in the Professional version.

Instant Update Service

EES uses a different model for updating than most other programs. Each time that there is a change in the EES program, either to correct a problem or to add a new feature, the version number is incremented by 0.001 and the latest version of EES is placed on our website. Although the program has become very robust and stable, there have been many new versions of EES released since the last EESy Solutions was distributed in the Fall of 2013.

Any user who has a current subscription to our Instant Update Service can download the latest version. All new non-academic EES licenses include one year of Instant Update and Technical Service. Information on renewing this service after the first year are provided on the F-Chart website at http://fchart.com/ees/instant-update.php.