# Introduction to EES - 1

#### 2.60/2.62/10.390 Fundamentals of Advanced Energy Conversion Spring 2020

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### Introduction to EES (Engineering Equation Solver)

EES is a computational platform and it can do the following:

- Derive numerical solution of a set of *non-linear algebraic equations*
- Solve differential and integral equations
- Perform *parametric studies*, optimization, uncertainty analysis and linear/non-linear regression

#### Highlights

- Thermo-physical property and transport properties
- Equations and unknowns to be entered in *any order*

#### EES Commands

10 pull down menus in the ribbon



- File
- Edit
- Search: Find and replace
- **Options**: Information and preference
- Calculate: Solve, Check Units, etc.

## EES Commands (cont.)

• 10 pull down menus in the ribbon

EES Academic Professional: File Edit Search Options Calculate Tables Plots Windows Help Examples

- Tables: Parametric studies
- Plots: Plot data in the Parametric studies
- Windows

Help

You'll probably be using the toolbar more often!

• Examples: good to explore

#### Example 1: Maximum work

- A gas tank contains 1 kg Argon at  $T_1 = 500$  K,  $P_1 = 1$  bar.
- Environment  $T_0 = 300$  K,  $P_0 = 1$  bar
- What is the maximum work of the gas tank?



### 1. Enter known quantities

- Start EES and enter the following in the Equations Window.
- What are the knowns?



### 2. Formatted Equations

Equations in mathematical notation (recommended Psets format)



<u>W</u> in	dows <u>H</u> elp E <u>x</u> amples
	Equations
	Formatted Equations
	Solution
	Arrays

#### 3. Enter equations



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- To calculate
  - Solve in Calculate menu.

Calculate Tables Plots Windows	Help Exam
Check/Format	Ctrl+K
Solve	F2
Solve Table	F3
Min/Max	F4
Min/Max Table	F5
Uncertainty Propagation	F6
Uncertainty Propagation Table	F7

#### 4. Check solutions

#### Solutions

		Main			
		Unit Settings: SI C	kPa J mass deg		
0	Solution →	C <sub>p</sub> = 523 [J/kg-K]	C <sub>V</sub> = 315 [J/kg-K]	E <sub>0</sub> = 94500	E <sub>1</sub> = 157500
		M = 1 [kg]	P <sub>0</sub> = 100000 [bar]	P <sub>1</sub> = 100000 [bar]	R = 208 [J/kg-K]
		$\rho$ = 1.784 [kg/m <sup>3</sup> ]	S <sub>0</sub> = 588.4	S <sub>1</sub> = 855.6	T <sub>0</sub> = 300 [K]
		T <sub>1</sub> = 500 [K]	$V_0 = 0.624$	V <sub>1</sub> = 1.04	W <sub>max</sub> = 24451
0	Unit 🔸	9 potential unit prob	lems were detected.	heck Units	
0	Time 🗲	Calculation time = .0	<sup>) sec.</sup> What is th	e problem?	

#### Undefined units in equation

ES	EES	Aca	Iden	nic	Prof	fessi	onal:	E:\D	ropb	ox (N	1IT)\2	2.60\:	slide	es\EE	S\ex	1.E
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e		A	5	ų	E.	<u> (</u>	Ľ	2 0 1-1		<mark>81</mark>	$\checkmark$	۷			$\bowtie$	G

"knowns" T\_0 = 300 [K]

P\_0 = 1\*10<sup>5</sup> [Pa] T\_1 = 500 [K] P\_1 = 1\*10<sup>5</sup> [Pa] M = 1 [kg]

"Maximum Work"  $W_{max} = (E_1 - T_0^*S_1 + P_0^*V_1) - (E_0 - T_0^*S_0 + P_0^*V_0)$   $E_1 = M^*C_v^*T_1$   $E_0 = M^*C_v^*T_0$   $V_1 = M^*R^*T_1/P_1$   $V_0 = M^*R^*T_0/P_0$ No unit [J] mentioned here. Try out what happens if you do add it here?

### 5. Setting Units

• Options  $\rightarrow$  Variable Information



#### No unit problems!

#### Main

#### Unit Settings: SI C kPa J mass deg

- $C_p = 523 [J/kg-K]$   $C_v = 315 [J/kg-K]$   $E_0 = 94500 [J]$
- E<sub>1</sub> = 157500 [J] M = 1 [kg]
- $S_0 = 0 [J/K]$   $S_1 = 267.2 [J/K]$   $T_0 = 300 [K]$

- $P_0 = 1000000$  [Pa]
- $P_1 = 1000000$  [Pa] R = 208 [J/kg-K]  $\rho = 1.784$  [kg/m<sup>3</sup>]
- $T_1 = 500$  [K]  $V_0 = 0.0624$  [m<sup>3</sup>]  $V_1 = 0.104$  [m<sup>3</sup>]

No unit problems were detected.

Calculation time = .0 sec.

 $W_{max} = 24451 [J]$ 

### 6. Initial Guess, Lower and Upper bounds

#### • Options $\rightarrow$ Variable Information

Options Calculate Tables Plots Windows Variable Info F9 Explore 'Computational Flow' and Function Info Ctrl+Alt+F 'Residuals' titles in the windows Unit Conversion Info menu to debug issues with solving Constants systems of equations. Unit System Ctrl+Alt+U Stop Criteria Ctrl+Alt+S Default Info 2 X Es Variable Information Show array variables 囼 Show string variables Variable Guess -Units Lower Upper Display • Kev Comment 523 infinity A 3 N J/kg-K Ср -infinity . 315 -infinity Cv infinity A 3 N J/kg-K E 0 94500 infinity A 3 N -infinity E 1 157500 -infinity infinity A 3 N м -infinity infinity A 3 N kg infinity A 0 N Pa 1000000 P 0 -infinity P 1 -infinity infinity A 0 N Pa 1000000

#### **Example 2: Parametric Studies**

- A gas tank contains 1 kg Argon at  $T_1$ ,  $P_1 = 1$  bar.
- Environment  $T_0 = 300$  K,  $P_0 = 1$  bar
- How does  $T_1$  affect the maximum work  $(W_{max})$ ?



### T1 is unknown

- Start EES and enter the following in the Equations Window.
- What are the knowns?



X

## Comments: { } or " "

#### • Equations

😼 File Edit Search Options Calculate Tables Der 🔁 🖶 🤐 🛱 🕵 💵 🛐 🖼 💵 🗸 🎸 🗑	Plots Windows Help Examples
"knowns" ← . T_0 = 300 [K] P_0 = 10e5 [Pa]	Comments
{T_1 = 500 [K]} P_1 = 10e5 [Pa] M = 1 [kg]	
rho = 1.784 [kg/m^3] R = 208 [J/kg-K]	
C_p = 523 [J/kg-K]	

 $C_v = 315 [J/kg-K]$ 

Formatted Equations

EEs File Ec	dit Sear	ch Opt	ions	Calcul	ate 1	ables	; P	lo
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#### knowns

 $T_0 = 300 [K]$   $P_0 = 1000000 [Pa]$   $P_1 = 1000000 [Pa]$  M = 1 [kg]  $\rho = 1.784 [kg/m^3]$  R = 208 [J/kg-K]  $C_p = 523 [J/kg-K]$  $C_v = 315 [J/kg-K]$ 

## Parametric Table for T<sub>1</sub> and W<sub>max</sub>

- Study the relationship between unknowns.
- Tables → New Parametric Table

		Tables Plots Wildows Help Exampl
		New Parametric Table
		Alter Values
		Retrieve Parametic Table
		Store Darametric Table
		Store Parametric Table
w Parametric Table		Insert/Delete Runs
lo. of Runs 10 🔶 Ta	able: Table 1	
Variables in equations	١	/ariables in table
R rho S_0 S_1 T_0	Add ->	
1 1 ▼_0 ▼_1 ₩_max	E <> Remove	
Show Array Variables		
🧹 ОК	47	X Cancel
	17	

Tables Dista Windows Hale Evana

#### Define the range of study

• After chosen the two variables  $T_1$  and  $W_{max}$ 



- The range of  $T_1$ 
  - 300 1000 K

#### Run

Click the green button on the left

Table 1		
< <b>₩</b> > 16	¹ T <sub>1</sub> ⊻ [K]	² ▼ W <sub>max</sub> [J]
Run 1	300	0
Run 2	400	7163
Run 3	500	24451
Run 4	600	48145
Run 5	700	76259
Run 6	800	107608

#### Plot the results

Plots Windows Help	Examples		
New Plot Window	۲.	X-Y Plot	Ctrl+Alt+X
Overlay Plot		Bar Plot	Ctrl+Alt+B
Modify Plot		X-Y-Z Plot	Ctrl+Alt+Z
Modify Axes		Polar Plot	Ctrl+Alt+P
Show Tool Bar	Ctrl+T		
Delete Plot Window			
Property Plot			
Curve Fit			
Plot Thumbnails			

### Choose X and Y axes

New Plot Setup		? ×
Tab Name: Plot 1		Print Description with plot
Description:		
X-Axis	Y-Axis	Table
T_1 ₩ max	T_1 ₩ max	Parametric Table 🗾
_		Table 1
		First Run 1 韋
		Last Run 6 🚖
		🔲 Spline fit
Format It I	Format 1	Automatic update
Fulliat A 4	Fulliat A 4	Show array indices
		Show error bars
Maximum 800	Maximum   120000	Line
Interval 100	Interval 20000	Symbol None -
🖲 Linear 🦳 Log	🤨 Linear 🦳 Log	Color Auto -
Grid lines	🔲 Grid lines	V OK X Cancel

#### View and Edit the Graph

• Change the plot axes/labels by double clicking on them.



#### Example 3: Problem

- An open Brayton-cycle engine operates with a compressor-pressure ratio of 4.5 and inlet temperature of 20°C, and a turbine-inlet temperature of 900°C.
- The engine drives an electric generator that produces 25 MWe with a generator efficiency of 90%.
- Find the thermal efficiency, the specific work, and the air-mass-flow rate, if the compressor and turbine efficiencies are 80 percent.



#### **Example 3: Equations**

Assume air as ideal gas with constant  $C_{p}$  $C_{p} = 1.005$ k = 1.40 $\frac{T_{2s}}{T_1} = r_c^{\frac{k-1}{k}}$  $\frac{T_{2s} - T_1}{T_2 - T_1} = \eta_c$ Compressor  $w_c = C_p \quad T_2 - T_1$  $q_{in} = C_n T_3 - T_2$  $\frac{T_{4s}}{T_3} = 1/r_t^{\frac{k-1}{k}}$  $\frac{T_4 - T_3}{T_{4s} - T_3} = \eta_t$ Turbine  $w_t = C_p T_3 - T_4$  $\eta_{th} = \frac{w_t - w_c}{q_{in}}$  $\dot{W} = \dot{W}_{gen} / \eta_{gen}$  $\dot{m} = \dot{W} / w_t - w_c$ 

"Assume air as ideal gas with constant Cp" Cp = 1.005 [kJ/kg.K]K = 1.40 $T_{2s}/T_1 = r_{p-c}^{(k-1)/k}$  $T_2 = T_1 + 1/\eta_c(T_{2s} - T_1)$  $W_c = Cp(T_2 - T_1)$  $Q_{in} = Cp(T_3 - T_2)$  $T_{4s}/T_3 = 1/r_{p-t}^{(k-1)/k}$  $T_4 = T_3 - \eta_t (T_3 - T_{4s})$  $W_t = Cp(T_3 - T_4)$  $\eta_{th} = (W_t - W_c)/Q_{in}$ W dot = W dot gen/ $\eta_a$  $m_dot = W_dot/(W_t-W_c)$ 24

#### **Example 3: Equations**

#### Equations Window

C\_p = 1005 [J/kq-K] k = 1.40 eta c = 0.80 eta t = 0.80 rpc=4.5 $r_p_t = 4.5$ eta\_e = 0.90 T\_min = 293 [K] T\_max = 1173 [K] W\_dot\_e = 25000000 [W] W dot m = W dot e/eta e "Simple Brayton Cycle" "compressor"  $T1 = T_min$  $Ts2 = T1 * (r_p_c)^{((k-1)/k)}$ T2 = T1 + (1/eta\_c)\*(Ts2 - T1)  $w_c = C_p^*(T2 - T1)$ "turbine" T3 = T max  $Ts4 = T3 * (1/r_p_t)^{(k-1)/k}$ T4 = T3 - eta\_t\*(T3 - Ts4)  $w t = C p^{*}(T3 - T4)$ w\_net=w\_t-w\_c  $q_{in} = C_p * (T3 - T2)$ eta\_th = w\_net/q\_in m\_dot = W\_dot\_m/w\_net

"Assume air as ideal gas with constant Cp" Cp = 1.005 [kJ/kg.K] K = 1.40

 $T_{2s}/T_{1} = r_{p-c}^{(k-1)/k}$   $T_{2} = T_{1} + 1/\eta_{c}(T_{2s}-T_{1})$  $W_{c} = Cp(T_{2}-T_{1})$ 

 $Q_{in} = Cp(T_3 - T_2)$ 

 $T_{4s}/T_3 = 1/r_{p-t}^{(k-1)/k}$   $T_4 = T_3 - \eta_t(T_3 - T_{4s})$  $W_t = Cp(T_3 - T_4)$ 

 $\eta_{th} = (W_t - W_c)/Q_{in}$ 

 $W_dot = W_dot\_gen/\eta_g$  $m_dot = W_dot/(W_t-W_c)$ 

#### **Example 3: Units**

• Options  $\rightarrow$  Variable Information

Show array variables Show string variables								
Variable	Guess 👻	Lower	Upper	Display	Units	Кеу	Comment	
С_р [	infinity	-infinity	infinity	A 3 N J/	'kg-K			_
eta_c	infinity	-infinity	infinity	A 3 N				
eta_e	infinity	-infinity	infinity	A 3 N				
eta_t	infinity	-infinity	infinity	A 3 N				
eta_th	infinity	-infinity	infinity	A 3 N				
k	infinity	-infinity	infinity	A 3 N				
m_dot	infinity	-infinity	infinity	A 3 N				
q_in	infinity	-infinity	infinity	A 1 N				
r_p_c	infinity	-infinity	infinity	A 3 N				
rpt	infinity	-infinity	infinity	A 3 N				
T1	infinity	-infinity	infinity	A 1 N				
T2	infinity	-infinity	infinity	A 1 N				
T3	infinity	-infinity	infinity	A 1 N				
T4	infinity	-infinity	infinity	A 1 N				
Ts2	infinity	-infinity	infinity	A 1 N				
Ts4	infinity	-infinity	infinity	A 1 N				
T max	infinity	-infinity	infinity	A1NK				
T min	infinity	-infinity	infinity	A1NK				
wc	infinity	-infinity	infinity	A 1 N				
W dot e	infinity	-infinity	infinity	A 1 N W	/			
W dot m	infinity	-infinity	infinity	A 1 N				
w net	infinity	-infinity	infinity	A 1 N				
w t	infinity	-infinity	infinity	A 1 N				
·· <u>-</u> ·							26	



#### **Example 3: Initial Guess**

- It is usually a good idea to set the guess values and (possibly) the lower and upper bounds for the variables before attempting to solve the equations.
- The Variable Information dialog contains a line for each variable appearing in the Equations window. By default, each variable is given a guess value of 1.0 with lower and upper bounds of negative and positive infinity before solving. Variable Information

Show array variables Show string variables										[
Variable	Guess 👻	Lower	Upper	Di	spl	ay	Units	Key	Comment	
С_р [	infinity	-infinity	infinity	A	3	Ν	J/kg-K			
eta_c	infinity	-infinity	infinity	А	3	Ν				
eta_e	infinity	-infinity	infinity	А	3	Ν				
eta_t	infinity	-infinity	infinity	А	3	Ν				
eta_th	infinity	-infinity	infinity	А	3	Ν				
k	infinity	-infinity	infinity	А	3	Ν				
m_dot	infinity	-infinity	infinity	А	3	Ν	kg/s			
q_in	infinity	-infinity	infinity	Α	1	Ν	J/kg			
r_p_c	infinity	-infinity	infinity	Α	3	Ν				
r_p_t	infinity	-infinity	infinity	Α	3	Ν				
T1	infinity	-infinity	infinity	Α	1	Ν	К			
T2	infinity	-infinity	infinity	А	1	Ν	к			
T3	infinity	-infinity	infinity	А	1	Ν	К			
T4	infinity	-infinity	infinity	A	1	Ν	К			
Ts2	infinity	-infinity	infinity	A	1	Ν	к			
Ts4	infinity	-infinity	infinity	А	1	Ν	К			
T max	infinity	-infinity	infinity	А	1	Ν	К			
Tmin	infinity	-infinity	infinity	A	1	Ν	К			
w c	infinity	-infinity	infinity	A	1	Ν	J/kg			
W dot e	infinity	-infinity	infinity	А	1	Ν	W			
W dot m	infinity	-infinity	infinity	A	1	Ν	W			
w net	infinity	-infinity	infinity	A	1	Ν	J/kg			
wt	infinity	-infinity	infinity	A	1	Ν	J/kg			
-			,				Ŭ			

#### **Example 3: Mathematical Notation**

🕰 EES Academic Professional: E:\Dropbox (MIT)\2.60\slides\EES\EES\_Tutorials\ex2.EES - [Formatted Equa Es File Edit Search Options Calculate Tables Plots Windows Help Examples ╘ 🔒 🖉 📴 🖭 🖬 🗊 🖌 🖌 🗑 🖬 🖂 🔟 🖾 🖾 🖉 🖉 🖬  $C_{p} = 1005 [J/kg-K]$ k = 1.4 $\eta_c = 0.8$  $\eta_{t} = 0.8$  $r_{p,c} = 4.5$  $r_{p,t} = 4.5$  $T_{min} = 293$  [K]  $T_{max} = 1173 [K]$ Simple Brayton Cycle compressor  $T1 = T_{min}$  $Ts2 = T1 \cdot r_{p,c} \left[\frac{k-1}{k}\right]$  $T2 = T1 + \frac{1}{2} \cdot (Ts2 - T1)$ ηc 28  $w_{c} = C_{p} \cdot (T2 - T1)$ 

#### **Example 3: Solution**

• The display and other defaults can easily be changed with the Default information command in the Options menu.

Main				
Unit Settings: SI K Pa J mass deg				
C <sub>p</sub> = 1005 [J/kg-K]	η <sub>c</sub> = 0.8	ηe = 0.9	η <b>t</b> = 0.8	η <sub>th</sub> = 0.192
k = 1.4	m = 210.7 [kg/s]	q <sub>in</sub> = 686795 [J/kg]	r <sub>p,c</sub> = 4.5	$r_{p,t} = 4.5$
T1 = 293 <b>[K]</b>	T2 = 489.6 [K]	T3 = 1173 <b>[K]</b>	T4 = 845.2 [K]	Ts2 = 450.3 [K]
Ts4 = 763.2 [K]	T <sub>max</sub> = 1173 [K]	T <sub>min</sub> = 293 [K]	w <sub>c</sub> = 197605 [J/kg]	Ŵ <sub>e</sub> = 2.500E+07 [
Ŵ <sub>m</sub> = 2.778E+07 [₩	/] w <sub>net</sub> = 131835 [J/kg]	w <sub>t</sub> = 329440 [J/kg]		

No unit problems were detected.

Calculation time = .0 sec.

#### Example 3: Parametric Studies

- Tables → New Parametric Table
- A dialog will be displayed listing the variables appearing in the Equations window.
- In this case, we will construct a table containing the variables eta\_c and eta\_th.
- Click on eta\_cfrom the variable list on the left. This will cause it to be highlighted and the Add button will become active. Repeat for eta\_th, using the scroll bar to bring the variable into view if necessary.
- As a short cut, you can double-click on the variable name in the list on the left to move it to the list on the right. You can also select multiple variables at one time.
- Click the Add button to move the selected variables into the list on the right and then click the OK button to create the table.

New Parametric Ta	ıble	? 🔀
No. of Runs 10 🚔 Ta	able: Table 1	
Variables in equations		Variables in table
С_р		
eta_c		
eta_t		
eta_th		
m_dot	1	
q_in	<⊨ Remove	
r_p_c rpt	•	
Show Array Variables		
V OK		🗙 Cancel

### **Example 3: Equations**

- Parametric Table works much like a spreadsheet. You can type numbers directly into the cells. Numbers that you enter are shown in black and produce the same effect as if you set the variable to that value with an equation in the Equations window.
- Delete the eta\_c= 0.8 equation currently in the Equations window or enclose it in comment brackets { }. This equation will not be needed because the value of eta\_c will be set in the table.

#### Example 3: Parametric Table

- Now enter values of eta\_c in the table for which eta\_th is to be determined. Values of eta\_c between 0.5 to 0.95 have been chosen for this example.
- (The values could also be automatically entered using Alter Values in the Tables menu or by using the Alter Values control at the upper right of each table column header.)

🔤 Parame	etric Ta <mark>P</mark> e	
Table 1		
▶ 99	1 Σ η <sub>c</sub>	² Σ ™th
Run 1	0.5	
Run 2	0.55	
Run 3	0.6	
Run 4	0.65	
Run 5	0.7	
Run 6	0.75	
Run 7	0.8	
Run 8	0.85	
Run 9	<u>D</u> .9	
Run 10	0.95	

#### **Example 3: Solution**

- Calculate  $\rightarrow$  Solve Table
  - The Solve Table dialog window will appear, allowing you to choose the runs for which calculations will be done.
  - When the Update Guess Values control is selected, the solution for the last run will provide guess values for the current run. Click the OK button.
  - When the calculations are completed, the calculated values of eta\_th will be entered into the table.

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Solve Table	? 🔀
Table Table 1	~
First Run Number 💌 1 🜲	
Last Run Number 💌 10 🜩	
✓ Update guess values	
Stop if error occurs	🖌 οκ
Use input from Diagram	
Solve in reverse order	X Cancel

🕾 Parametric Ta果e 🔳 🗖 🔀		
Table 1		
▶ 110	1 Σ η <sub>c</sub>	²
Run 1	0.5	0.02336
Run 2	0.55	0.07038
Run 3	0.6	0.1062
Run 4	0.65	0.1345
Run 5	0.7	0.1573
Run 6	0.75	0.1762
Run 7	0.8	0.192
Run 8	0.85	0.2054
Run 9	0.9	0.217
Run 10	0.95	0.2271

#### Example 3: Plots

- Plot  $\rightarrow$  New Plot Window
  - The New Plot Setup dialog window will appear.
  - Choose eta\_c to be the X-axis by clicking on eta\_c in the X-axis list. Click on eta\_th in the Y-axis list. You may wish to adjust the scale limits or add grid lines. When you click OK, the plot will be constructed and the plot window will appear.

New Plot Setup		? 🔀
Tab Name: Plot 1		Print Description with plot
Description:		
X-Axis	Y-Axis	T able
eta_c eta_th	eta_c eta_th	Parametric Table
		Table 1
		First Run 1 븆
		Last Run 10 🚔
	1	Spline fit
Format A	Format A	Automatic update
Minimum 0.5	Minimum 0	Show array indices
Maximum 1	Maximum 0.25	Show error bars
Interval U.1	Interval U.U5	Symbol None -
€ Linear C Log	C Linear C Log	
Grid lines	Grid lines	🗸 OK 🗙 Cancel



### **Thermophysical Functions**

- EES has built-in property data for many engineering fluids. They are accessed as functions taking temperature, pressure etc. as arguments.
- These functions may be accessed from the Function Information Window:

C Math functions	C EES library routines
Fluid properties	C External routines
C Solid/liquid properties	
Function Info	<b>?</b> Fluid Info
ACENTRICFACTOR	• R12
CONDUCTIVITY [W/m-K]	R123
CV [kJ/kg-K]	H125
DENSITY (ka/m3)	B134a
DEWPOINT ICI	B134a ha -
ENTHALPY [kJ/kg]	B14
ENTROPY [kJ/kg-K]	, R141b
UIIMDAT (ka/ka)	* B143a

## Thermophysical Functions – Example 1

 $V_1 = M^*R^*T_1/P_1$  $V_0 = M^*R^*T_0/P_0$ 

=P\_1)

V\_1 = M\*volume(*Argon*,*T*=T\_1,*P*=P\_1) V\_0 = M\*volume(*Argon*,*T*=T\_0,*P*=P\_0)

The two ways of calculating volume are not entirely equivalent: the first set uses the ideal gas assumption.

EES gets its thermophysical properties from a variety of sources. See the entire catalog of thermophysical functions/properties at: <u>http://fchart.com/ees/eeshelp/fluid\_property\_information.htm</u>

### Recap: Formatting rules

- Upper and lower case  $\rightarrow$  **NOT** distinguished.
- Blank lines and spaces → ignored
- Comments must enclosed within { } or ""
  - In effect for lines
  - "" comments showed in Formatted Equations (recommended Psets format)
- Variable start with a letter
- Equations separated by newline 
   In the separated by newline Interview Interview
- Units → in [ ]

Happy EES'ing !

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2.60J Fundamentals of Advanced Energy Conversion Spring 2020

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