EML 3035 – Programming Concepts Project **S23**

Graphical User Interface

Due date

April 28th, 2023 @ 11:59PM. Late projects are not considered.

Goal

To gain familiarity with the Matlab App Designer by:

- Creating a simple GUI (App) to interpolate Thermodynamics tables.

Submission guidelines

Upload your app file (extension .mlapp). In case your app is using external files such as text files or Excel files, compress these files along with the app file into a zip folder and submit the zip folder.

Key functions

callback functions
properties
str2double
num2str
loops
if statements

Problem to be solved

Most of you have taken Thermodynamics at this point. Hence you will be familiar with the table shown in Figure 1.

TABLE A–17

Ideal-gas properties of air

T K	h kJ/kg	P_r	u kJ/kg	υ_r	$s°$ kJ/kg·K
200	199.97	0.3363	142.56	1707.0	1.29559
210	209.97	0.3987	149.69	1512.0	1.34444
220	219.97	0.4690	156.82	1346.0	1.39105
230	230.02	0.5477	164.00	1205.0	1.43557
240	240.02	0.6355	171.13	1084.0	1.47824
250	250.05	0.7329	178.28	979.0	1.51917
260	260.09	0.8405	185.45	887.8	1.55848
270	270.11	0.9590	192.60	808.0	1.59634
280	280.13	1.0889	199.75	738.0	1.63279
285	285.14	1.1584	203.33	706.1	1.65055
290	290.16	1.2311	206.91	676.1	1.66802
295	295.17	1.3068	210.49	647.9	1.68515
298	298.18	1.3543	212.64	631.9	1.69528
300	300.19	1.3860	214.07	621.2	1.70203
305	305.22	1.4686	217.67	596.0	1.71865
310	310.24	1.5546	221.25	572.3	1.73498
315	315.27	1.6442	224.85	549.8	1.75106
320	320.29	1.7375	228.42	528.6	1.76690
325	325.31	1.8345	232.02	508.4	1.78249
330	330.34	1.9352	235.61	489.4	1.79783
340	340.42	2.149	242.82	454.1	1.82790
350	350.49	2.379	250.02	422.2	1.85708
360	360.58	2.626	257.24	393.4	1.88543
370	370.67	2.892	264.46	367.2	1.91313
380	380.77	3.176	271.69	343.4	1.94001

TABLE A–17E

Ideal-gas properties of air

T R	h Btu/lbm	P_r	u Btu/lbm	υ_r	$s°$ Btu/lbm·R
360	85.97	0.3363	61.29	396.6	0.50369
380	90.75	0.4061	64.70	346.6	0.51663
400	95.53	0.4858	68.11	305.0	0.52890
420	100.32	0.5760	71.52	270.1	0.54058
440	105.11	0.6776	74.93	240.6	0.55172
460	109.90	0.7913	78.36	215.33	0.56235
480	114.69	0.9182	81.77	193.65	0.57255
500	119.48	1.0590	85.20	174.90	0.58233
520	124.27	1.2147	88.62	158.58	0.59173
537	128.10	1.3593	91.53	146.34	0.59945
540	129.06	1.3860	92.04	144.32	0.60078
560	133.86	1.5742	95.47	131.78	0.60950
580	138.66	1.7800	98.90	120.70	0.61793
600	143.47	2.005	102.34	110.88	0.62607
620	148.28	2.249	105.78	102.12	0.63395
640	153.09	2.514	109.21	94.30	0.64159
660	157.92	2.801	112.67	87.27	0.64902
680	162.73	3.111	116.12	80.96	0.65621
700	167.56	3.446	119.58	75.25	0.66321
720	172.39	3.806	123.04	70.07	0.67002
740	177.23	4.193	126.51	65.38	0.67665
760	182.08	4.607	129.99	61.10	0.68312
780	186.94	5.051	133.47	57.20	0.68942
800	191.81	5.526	136.97	53.63	0.69558
820	196.69	6.033	140.47	50.35	0.70160

Figure 1. Ideal-gas properties of air sorted by temperature, T, in Kelvin or Rankine. h stands for enthalpy, P_r for relative pressure and V_r is relative volume. Table on the left is SI units and table on the right is English units.

For a given temperature, we can obtain other properties such as enthalpy (h), relative pressure (P_r) or relative volume (V_r). Similarly, given a different property, such as enthalpy, we can also obtain the other properties that go along with such enthalpy. The problem arises when we need to look up properties for a temperature (or any other property) that is not directly given in our table. For instance, if my temperature is 326.3 K, what is the value of the other properties for such temperature? Or if my relative pressure (P_r) is 1.185, what is the value of the other properties corresponding to such P_r?

In these cases, we need to interpolate. The primary objective of your GUI will be to perform such interpolation for you given the value of one of the properties.

Interpolation equation

Let's think general. Imagine we know a variable with a value of x, which falls between values x_1 and x_2 given in the table. For such value of x, we need to find the value y of another variable. Figure 2 summarizes this idea in a graphical way.

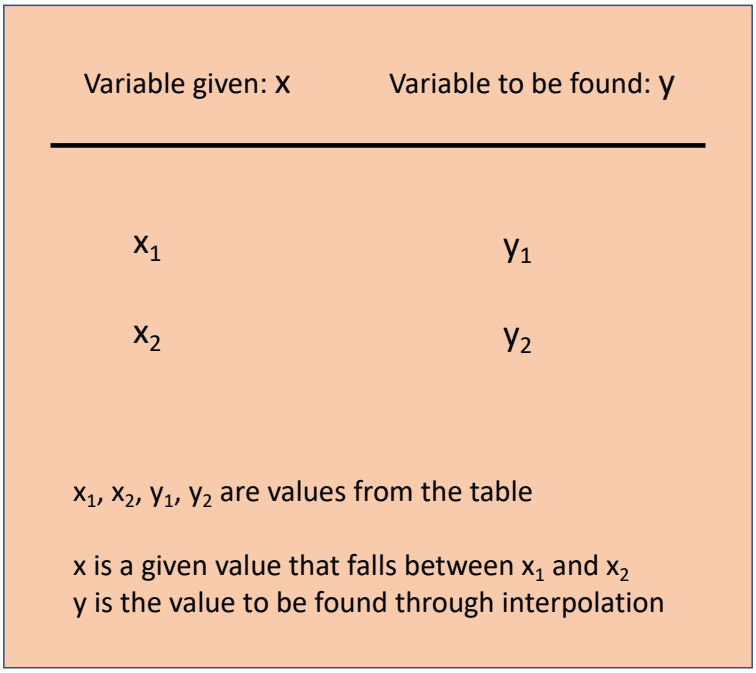

Figure 2. General table with variables x and y.

In order to find y we can use the following formula:

$$y = y_1 + \frac{y_2 - y_1}{x_2 - x_1}(x - x_1)$$

Feel free to use any other interpolation formula if you feel more comfortable with it, BUT do not use built-in interpolation functions such as *interp1()*, etc.

Basic design of GUI

This projects admits flexibility with the GUI design. At the very least, it should present the components shown in Figure 3.

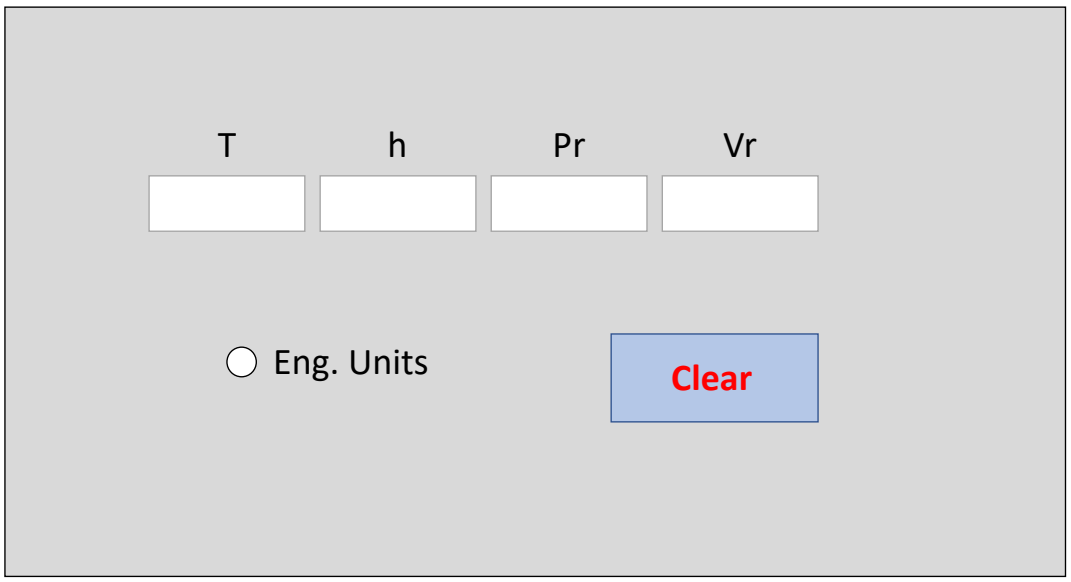

Figure 3. Basic GUI design. It contains 4 text boxes for temperature (T), enthalpy (h), relative pressure (Pr) and relative volume (Vr). Also, a units radio button and a clear push button.

Your GUI must at least contain:

- 4 text boxes for temperature (T), enthalpy (h), relative pressure (P_r) and relative volume (V_r).
- A units radio button group/check box/toggle switch/etc. The default units will be SI units. By clicking in the radio button, the user can interpolate values in the English units table.
- A clear push button that will erase all text boxes.

NOTE: the units radio button is not a units conversion button. It does not convert units. It is simply a way to choose which table you want to work with, either the one with SI units or the one with English units.

The way the GUI should work

Once completed, the way the GUI should operate is as follows: the user types in a value for one and only one of the 4 properties (temperature, enthalpy, relative pressure or relative volume) in the respective text box and when it hits enter, the rest of the text boxes should populate with the proper interpolated values for those properties.

If the user enters a value that is out range, the GUI should display an error message alerting the user about this issue. You can display this error in many ways: an edit text box, a dialog box, etc. Once the user gets the error message, the user can clear all boxes and type in a correct value. In the case of a dialog box, you can also block program execution until the user closes the dialog box (there is a specific function you can use for this).

When the user clicks on the CLEAR button, it should erase the content of all 4 text boxes at once.

When the user wants to work with the English units table, it should select the radio button and then enter a property value in the corresponding text box.

Table range

You do not need to type in the whole A-17 and A-17E tables into Matlab. You can limit yourself to the range of values shown in Figure 1. Keep in mind the only variables required for this GUI are temperature, enthalpy, relative pressure and relative volume. You can ignore the rest.

You can either manually enter the values for such table properties in your script or import them from an external file (For example, an Excel file). You can do so by creating two matrices: one for table A-17 and another for table A-17E. You can define these matrices in the Startup function (startupFcn) of your GUI script.

Grading criteria

The project will be graded based on completeness and proper operation of the GUI interface. Additional and unique features to the basic design **will also be rewarded**, but are not required.