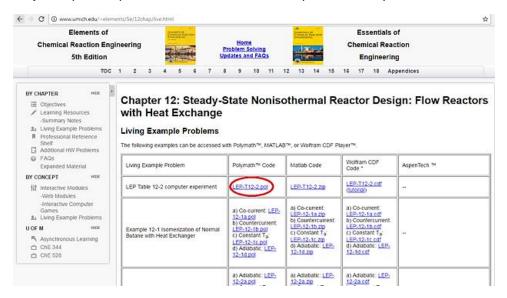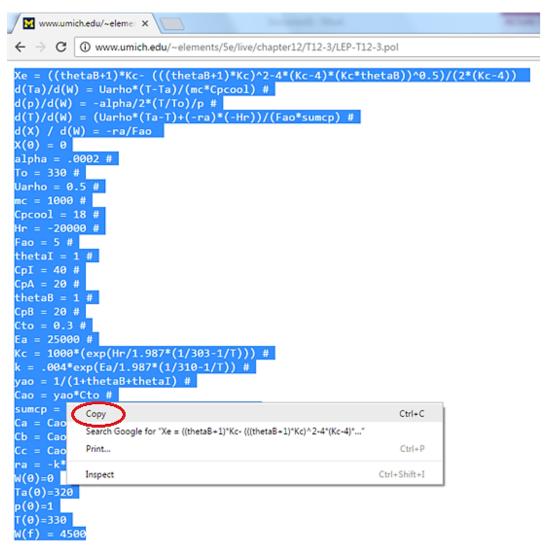**Step 1:** Open chapter 12 and click on LEP-T12-2.pol under Polymath™ Code



**Step 2:** After opening the file, you should see following window. Select all the code, right click and then copy the code

**Step 3**: Now you need to open Polymath software. Depending on what computer you are using, you may have to follow either **3.1** or **3.2** to open the software

### 3.1 Launching Polymath from computers/laptop other than University of Michigan CAEN computer

First make sure you have polymath installed. If you don't have it then refer to the installation instruction present on http://www.umich.edu/~elements/5e/software/polymath.html

After polymath is installed on your computer, then you can open it by either following 3.1.1 or 3.1.2
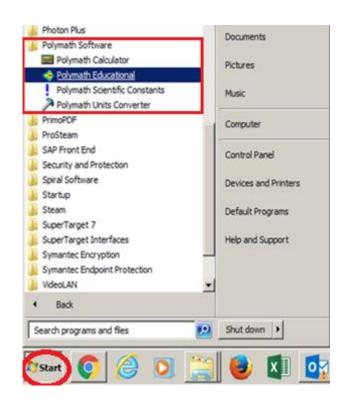
#### 3.1.1 From the desktop

On the desktop, you can find the icon for Polymath software. Put the cursor over the "Polymath" icon on the desktop (which may be Polymath Fogler/Polymath Educational/Polymath Professional), and **double** click on the icon using the left mouse button
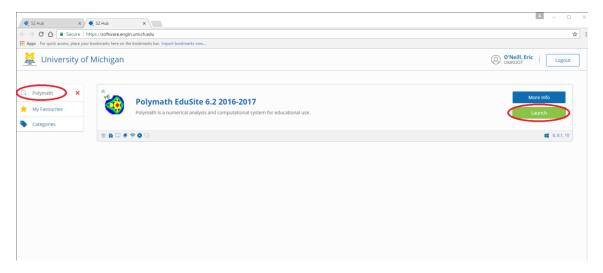


#### 3.1.2 From the Program menu

Click on the "Start" button in the bottom left corner of the screen and select "All Programs" from the pop-up menu. Then click on the Polymath software under which you will find Polymath icon
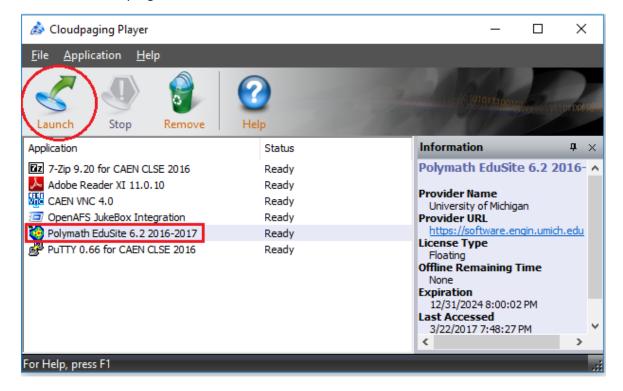
Click it to open the software

## 3.2 Launching Polymath from a University of Michigan CAEN computer

First, log in to a University of Michigan CAEN computer with your uniquename and password. Once logged in open Google Chrome and go to https://software.engin.umich.edu/ . In the upper left hand corner, use the search bar to search for 'Polymath.' The program "Polymath EduSite 6.2" will appear and you can click the green button labeled 'Launch' to start polymath.
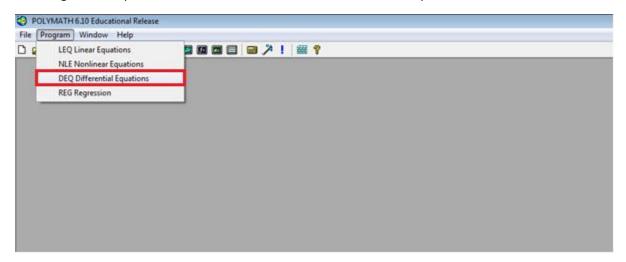


After pressing launch, the computer will open the Cloudpaging Player. Wait for Polymath to load then select it from the list of active programs and press launch (in the upper left corner). This will start the program.
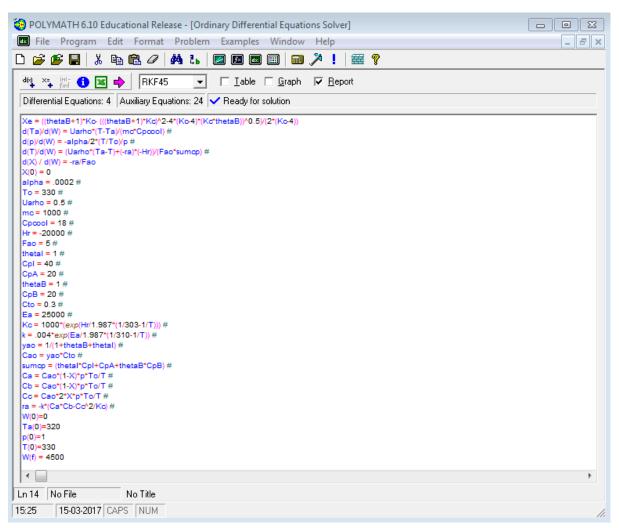


If the Cloudpaging Player doesn't open, then follow Step 3.1.1
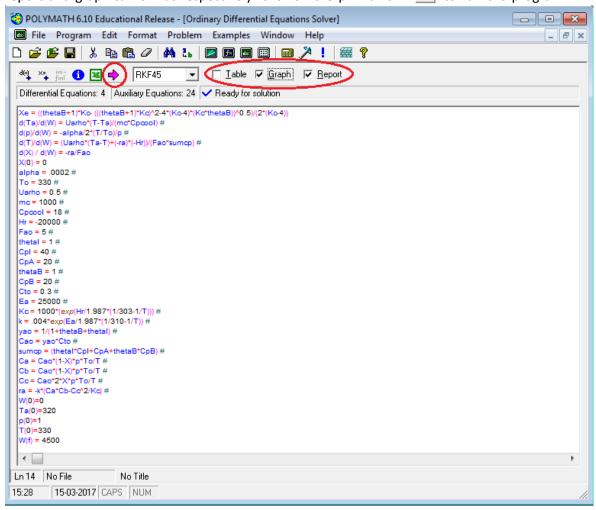
**Step 4:** After opening Polymath, you should see that a window opens which look like this. Click on "Program" tab present on toolbar and select "DEQ Differential Equations"
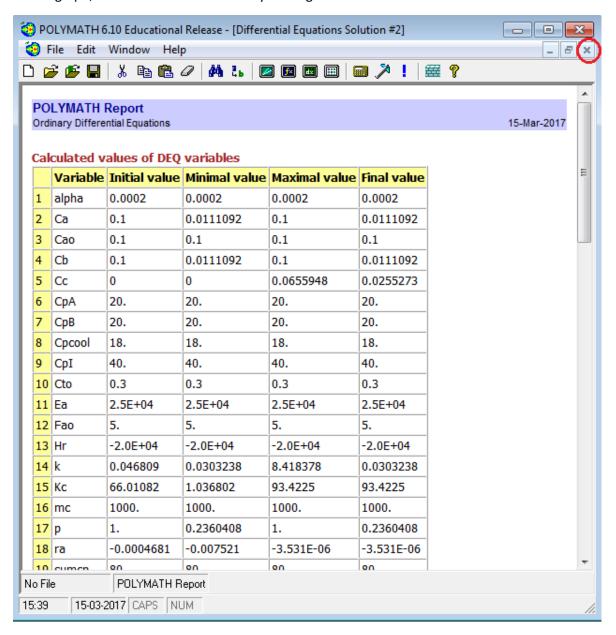


**Step 5:** This will open up another window. Right click on the white space and select Paste option to put the code in the space
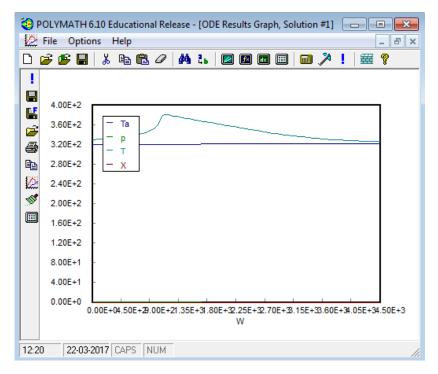
**Step 6:** Check the boxes corresponding to Report and Graph option to generate solution in report and graphical format respectively. Click on the pink arrow ➡ to run the program
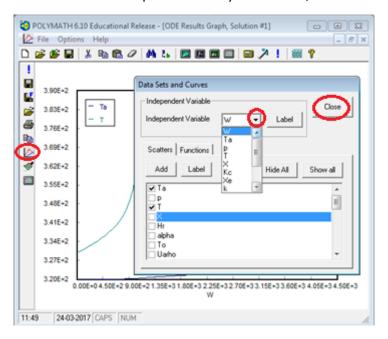
**Step 7:** You should see that Polymath report is generated in a new window. The report gives various information such as initial and final values of every variable present, the minimum and maximum values of the variables in the given interval, and the equations you entered. To obtain graph, close the current window by clicking on "X" button
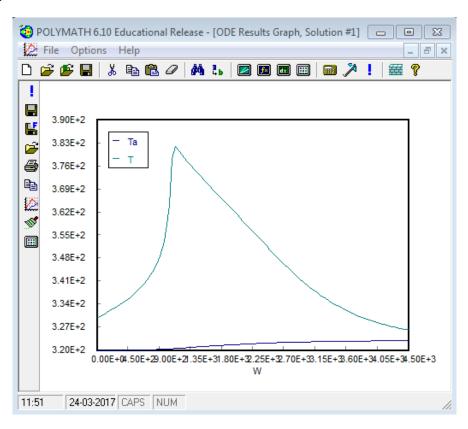
POLYMATH 6.10 Educational Release - [Differential Equations Solution #2]

File   Edit   Window   Help

**POLYMATH Report**
Ordinary Differential Equations                                                                    15-Mar-2017

**Calculated values of DEQ variables**

| | Variable | Initial value | Minimal value | Maximal value | Final value |
|---|---|---|---|---|---|
| 1 | alpha | 0.0002 | 0.0002 | 0.0002 | 0.0002 |
| 2 | Ca | 0.1 | 0.0111092 | 0.1 | 0.0111092 |
| 3 | Cao | 0.1 | 0.1 | 0.1 | 0.1 |
| 4 | Cb | 0.1 | 0.0111092 | 0.1 | 0.0111092 |
| 5 | Cc | 0 | 0 | 0.0655948 | 0.0255273 |
| 6 | CpA | 20. | 20. | 20. | 20. |
| 7 | CpB | 20. | 20. | 20. | 20. |
| 8 | Cpcool | 18. | 18. | 18. | 18. |
| 9 | CpI | 40. | 40. | 40. | 40. |
| 10 | Cto | 0.3 | 0.3 | 0.3 | 0.3 |
| 11 | Ea | 2.5E+04 | 2.5E+04 | 2.5E+04 | 2.5E+04 |
| 12 | Fao | 5. | 5. | 5. | 5. |
| 13 | Hr | -2.0E+04 | -2.0E+04 | -2.0E+04 | -2.0E+04 |
| 14 | k | 0.046809 | 0.0303238 | 8.418378 | 0.0303238 |
| 15 | Kc | 66.01082 | 1.036802 | 93.4225 | 93.4225 |
| 16 | mc | 1000. | 1000. | 1000. | 1000. |
| 17 | p | 1. | 0.2360408 | 1. | 0.2360408 |
| 18 | ra | -0.0004681 | -0.007521 | -3.531E-06 | -3.531E-06 |
| 19 | cumcn | 80 | 80 | 80 | 80 |

No File          POLYMATH Report

15:39          15-03-2017   CAPS   NUM

**Step 8:** You should obtain graph which looks like this. By default, Polymath plots all the dependent variable simultaneously on Y axis and independent variable on X axis
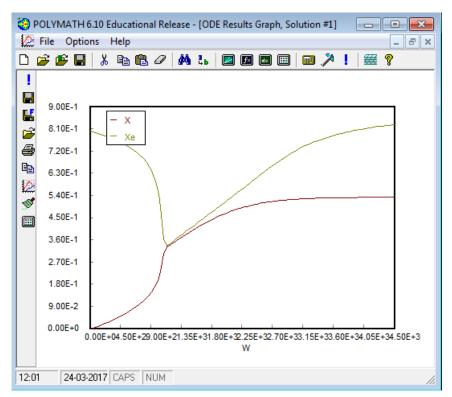


**Step 9:** To select the variable you want to plot, double click on the graph or click on graph button present on left panel (shown below). This will open up a dialogue box. You can select independent variable from drop- down menu and dependent variable by checking/unchecking the boxes next to the variables. Let's select independent variable as W and dependent variable as T and Ta. So uncheck the boxes for p and X. After you are done, hit Close button

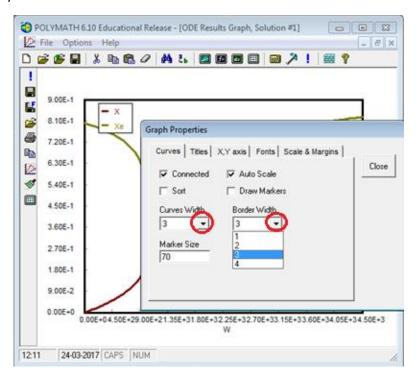Choosing W as independent variable and T & Ta as dependent variable, your graph should look like this



**Step 10:** Now choose X & Xe as dependent variable with same independent variable i.e.W and plot your graph. It should look like this

**Step 11:** To edit graph properties right click on graph and select "Format" or click on brush button present on the left panel. This will open up a dialogue box with different tabs such as Curves, Titles, Fonts, axis format, margin etc. In this tutorial we will edit some of the graph properties
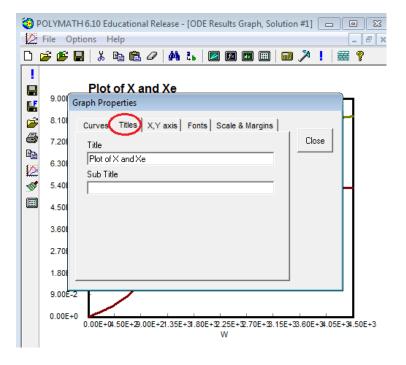
### 11.1 Changing Curve and border width

Let's select Curve and border width as 3 using drop down menu as shown below. Click on Close button after you are done.
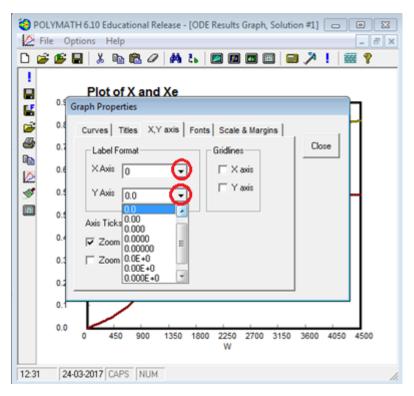


### 11.2 Adding Title to graph

Click on "Titles" Tab and put the graph title as Plot of X and Xe
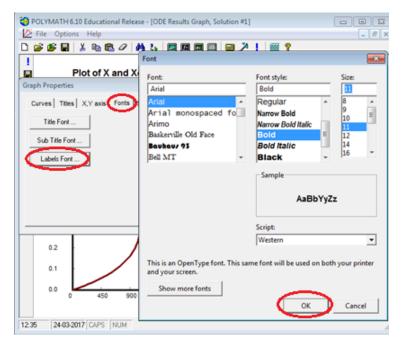
### 11.3 Format X, Y axis

To change the number of decimal places on X, Y axis, go to "X, Y axis" tab and change the X axis format to 0 and Y axis to 0.0 using drop down menu as shown below
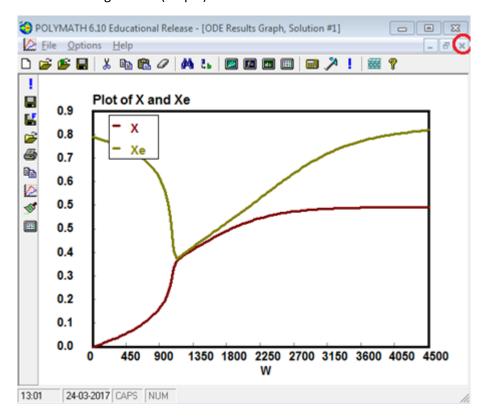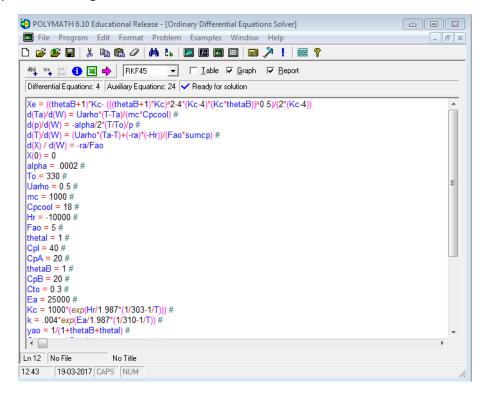


### 11.4 Font

To change the Title font or Label font, click on "Fonts" Tab. Let's change the Label font for this graph. Click on Label font. This will open up another dialogue box where you can select your font, font style and font size. Select Arial, Bold and 11 as Label font, font style and font size respectively. Press Ok button and close the graph dialogue box.
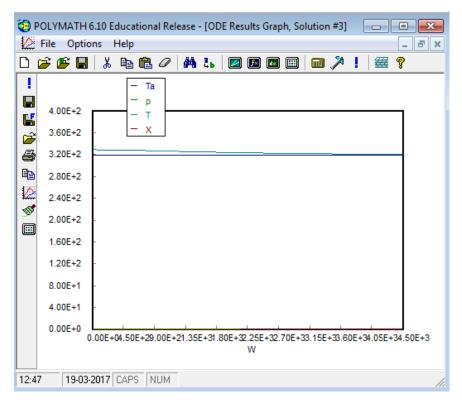
**Step 12:** You should see that your graph properties has now changed and look like this. You can also move your Title and Legend to anywhere in the graph by just dragging them. To go back to the coding section (Step 5) click on X button.
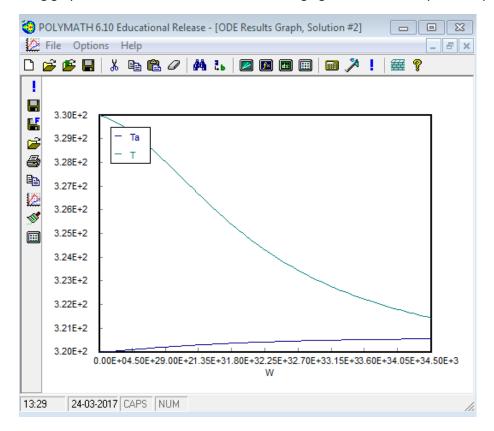


**Step 13:** To Change any parameter values, you can simply modify your code by going back to Step 5. Let's change Hr value from -20000 to -10000 as shown below
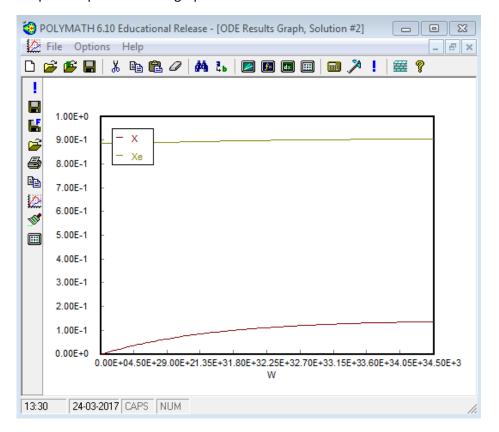
**Step 14.** Now run your file to generate report and graph as per new value of Hr. The following graph will be obtained. Again you can choose the variables you want to plot and edit graphical features.



**Step 15:** Repeat Step 9 to obtain the graph of T and Ta as a function of W. You shall obtain the following graph. You can now see the effect of changing Hr value on Temperature profile

**Step 16:** Repeat Step 10 to obtain graph of X and Xe as a function of W at new Hr value.



**Step 17:** Now you can try to change any other parameter and see the effect on graph. For additional help, consult the Polymath help file by go to the "Help" pull-down menu and select "Contents"