Using Matlab in Engr 17

Tips on speeding up the analysis of linear equations

Engr 17 - Introductory Circuit Analysis

Instructor: Russ Tatro

Overview

In **Circuit Theory** it is quite common that the analysis creates a **set of linear equations.**

The solution of that set of linear equations is the independent variables sought for in the analysis.

Matlab is a very useful tool to speed up the process of finding those independent variables.

How to get Matlab – Matlab Portal

CSU has licensed a University level Matlab.

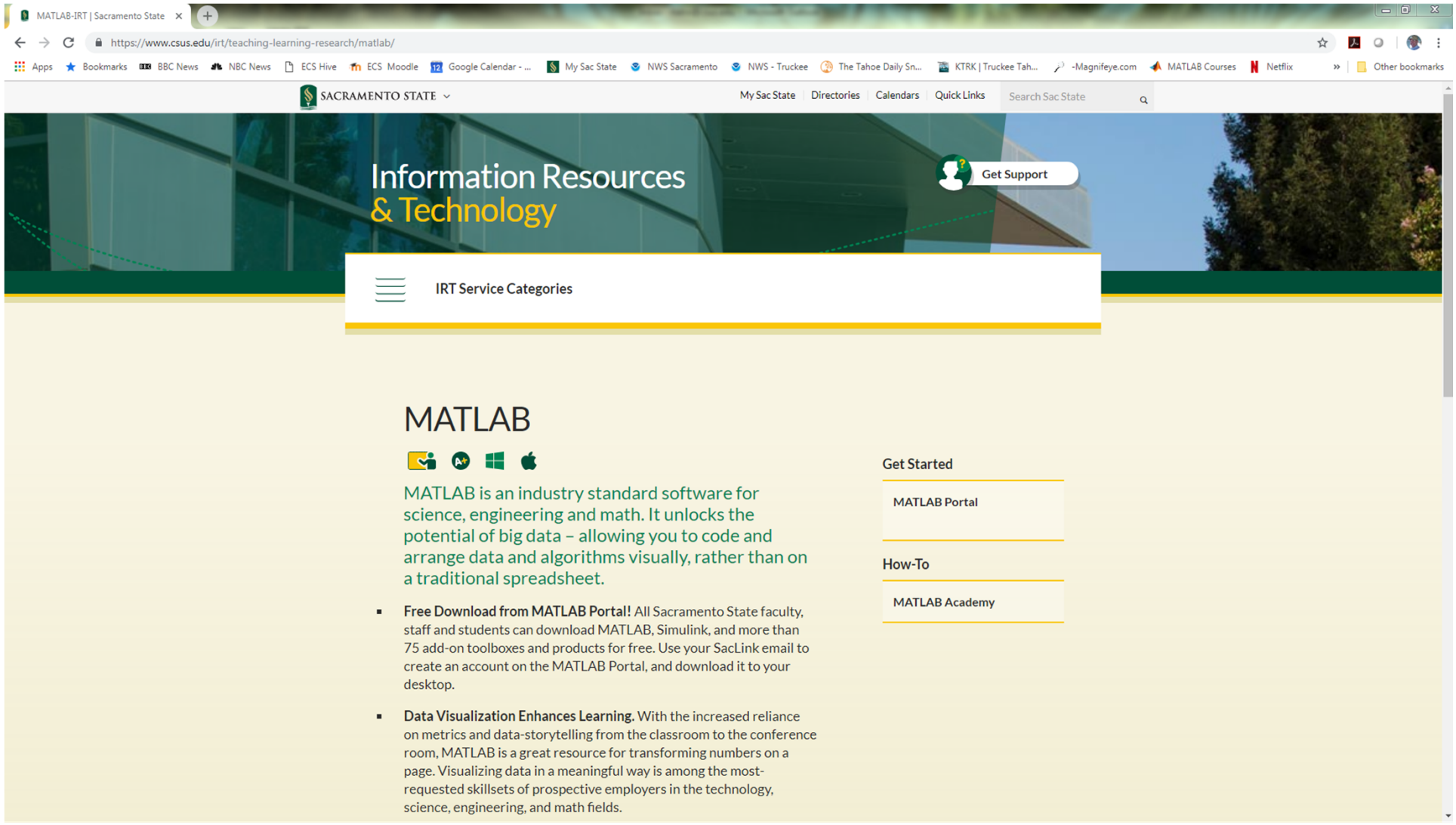
Free download from the CSUS IRT Matlab Portal.

https://www.csus.edu/irt/teaching-learning-research/matlab/

Log into the download site with your **Saclink** user name and password.

Create a Matlab account with a user name and password (different from your Saclink credentials).

Be ready for a very large and lengthy download process.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Get Started
MATLAB Portal
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MATLAB Academy

How to get access to Matlab – Terminal Server

Remote Desktop Connection into the ECS server *Hydra*

hydra.ecs.csus.edu

Most OS's have remote desktop connection. Windows (7, 8, 8.1) and Mac OX10 (all versions up through Yosemite) have been tested and confirmed to work.

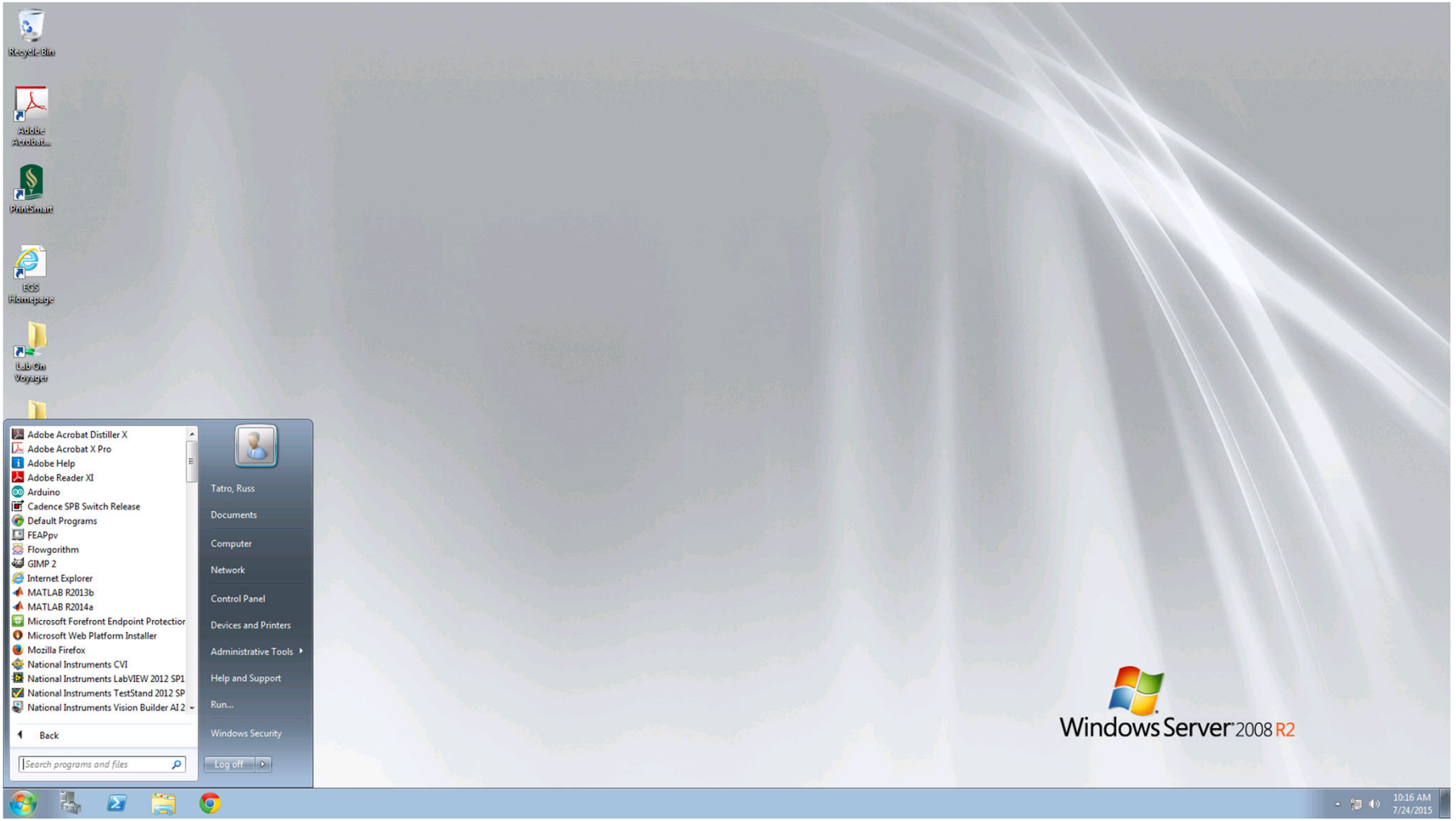
Open *Remote Desktop Connection, enter* hydra.ecs.csus.edu
and then provide your ECS credentials (NOT your saclink stuff)

After a short wait, you will see a remote desktop on your computer. You use this remote desktop just like any Windows system.

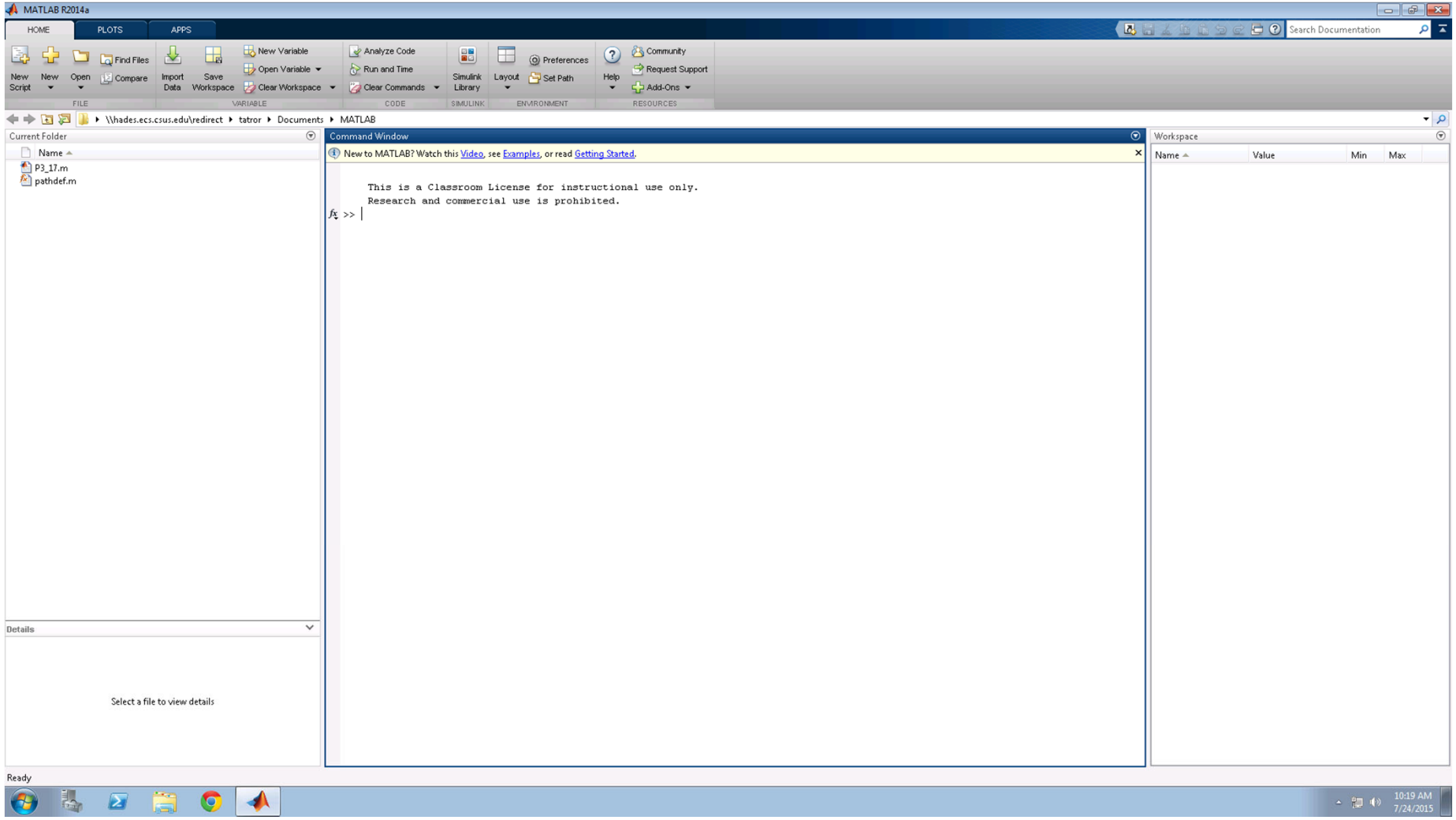
Go to the *Start* menu, then *All Programs,* then *Matlab R20xx*

You may find more than one version of Matlab on the terminal server. All versions work with the Matlab scripts I have created for you.

Hydra terminal server screen shot



Matlab – opening screen



Pick and then fully learn your tool of choice

Disclaimer: Matlab is just one tool.

Many of your calculators may also solve the linear equations just fine.

Matlab does solve linear equations that include complex numbers.

Entering the variables

So my analysis technique is to quickly but accurately create the needed equations.

You will not need to know the theory of Linear Algebra for this work.

But you will have to take the process on faith if you have not had a Linear Algebra course.

Speed up tip: I prefer to minimize how many numbers I calculate before I go to Matlab.

Maxtrix Setup

The process is to create a set of equations in *Standard Form*.

Matlab requires these equations to be entered in as matrices.

The matrix form is **A** * **B** = **C**

$$\begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{bmatrix} \begin{bmatrix} B_1 \\ B_2 \end{bmatrix} = \begin{bmatrix} C_1 \\ C_2 \end{bmatrix}$$

The desired solution is matrix **B** = **C** / **A**

Stepping over some matrix operation theory, the desired solution is found by "taking the **inverse** of matrix **A** and then multiply that by matrix **C**".

The Matlab solution is **B** = inv(A) * **C**

Entering the variables

For example,

$$v_1(29) + v_2(-1) = 2,880V$$
$$v_1(-1) + v_2(17) = 240V$$

We have two equations and two unknowns v_1 and v_2.

The matrix standard form is

$$\begin{bmatrix} 29 & -1 \\ -1 & 17 \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} = \begin{bmatrix} 2,880 \\ 240 \end{bmatrix}$$

Matlab "code"

```
A = [29 -1; -1 17]
C = [2880; 240]
B = inv(A)*C
```

The Matlab Solution

Where Matlab reports B = [100; 20].

Which follows our standard form for $v_1 = 100V$ and $v_2 = 20V$.

Thus the full matrix solution is

$$\begin{bmatrix} 29 & -1 \\ -1 & 17 \end{bmatrix} \begin{bmatrix} 100 \\ 20 \end{bmatrix} = \begin{bmatrix} 2,880 \\ 240 \end{bmatrix}$$

When you get a Matlab solution, verify the solution by inserting the Matlab answer into your original set of linear equations and verify the equality.

$$100(29) + 20(-1) = 2,900 - 20 = 2,880$$

$$100(-1) + 20(17) = -100 + 340 = 240$$

Solution checks!

Complex numbers

Matlab allows complex numbers in the matrix.

For example,

$$v_1(10+j1)+v_2(-5)=1,200V$$
$$v_1(-3)+v_2(3+j1)=0V$$

We have two equations and two unknowns v_1 and v_2.

$$\begin{bmatrix} 10+j1 & -5 \\ -3 & 3+j1 \end{bmatrix}\begin{bmatrix} v_1 \\ v_2 \end{bmatrix}=\begin{bmatrix} 1,200 \\ 0 \end{bmatrix}$$

Matlab "code" (note that Matlab uses "i" and not "j")

```
A = [10+1*i  -5; -3  3+1*i]
C = [1200; 0]
B = inv(A)*C
```

The Matlab Solution

Where Matlab reports B = [180.82 - j82.19; 138.08 - j128.22].

Thus the full matrix solution is

$$\begin{bmatrix} 10+j1 & -5 \\ -3 & 3+j1 \end{bmatrix} \begin{bmatrix} v_1 = 180.82 - j82.19 \\ v_2 = 138.08 - j128.22 \end{bmatrix} = \begin{bmatrix} 1,200 \\ 0 \end{bmatrix}$$

The power (and time-saving virtue) of Matlab is more obvious with the complex number math.

$$(180.82 - j82.19)(10 + \text{j1}) + (138.08 - j128.22)(-5) = 1,200$$

$$(180.82 - j82.19)(-3) + (138.08 - j128.22)(3 + \text{j1}) = 0$$

Verify the last two equations on your own.

Matlab Scripts

I have provided several Matlab scripts (on the course Moodle site) that somewhat automate the computation.

You will not have time to manually solve the sets of linear equations during exams 2 and 3.

Use of Matlab is optional but use some method to get a computed solution quickly (calculator or other software such as minitab, Mathematica, SAS, …) that can handle complex numbers!

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