Project 1 - CSC 113 Introduction to MATLAB

Due Date: Monday, September 22nd, 2014 at 2:00pm (one hour before lecture).

Truss Evaluation Project

Created at North Carolina State University, in conjunction with Mathworks, the ***CADApps Truss Solver*** Matlab App is designed to provide students with a design tool that can rapidly calculate a solution to a complex engineering problem. In particular, the ***CADApps Truss Solver*** App allows for multiple design iterations to be calculated for any two-dimensional truss design.

For this project, you will write a MATLAB script that reads in data generated by the ***CADApps*** and presents information about the designed truss in the Command Window and via plots.

For this assignment, you will be able (but not required) to work in groups of two. Partners for this project are to be chosen independently; should you want to work in a group but are not able to find a partner, you are free to use the forum to find a partner for your project. Please note that you will only be able to work with each partner on one of the three projects this semester and must choose other partners for subsequent projects.

1 Project Requirements

1.1 Download and Install CADApps

Download the ***CADApps*** from Moodle. The installation file is called **CADApps.mlappinstall**
Watch the Installation Tutorial: https://www.youtube.com/watch?v=P-5Y2pmxgH4

1.2 Create a truss with CADApps

Using ***CADApps*** , you will create the following truss.

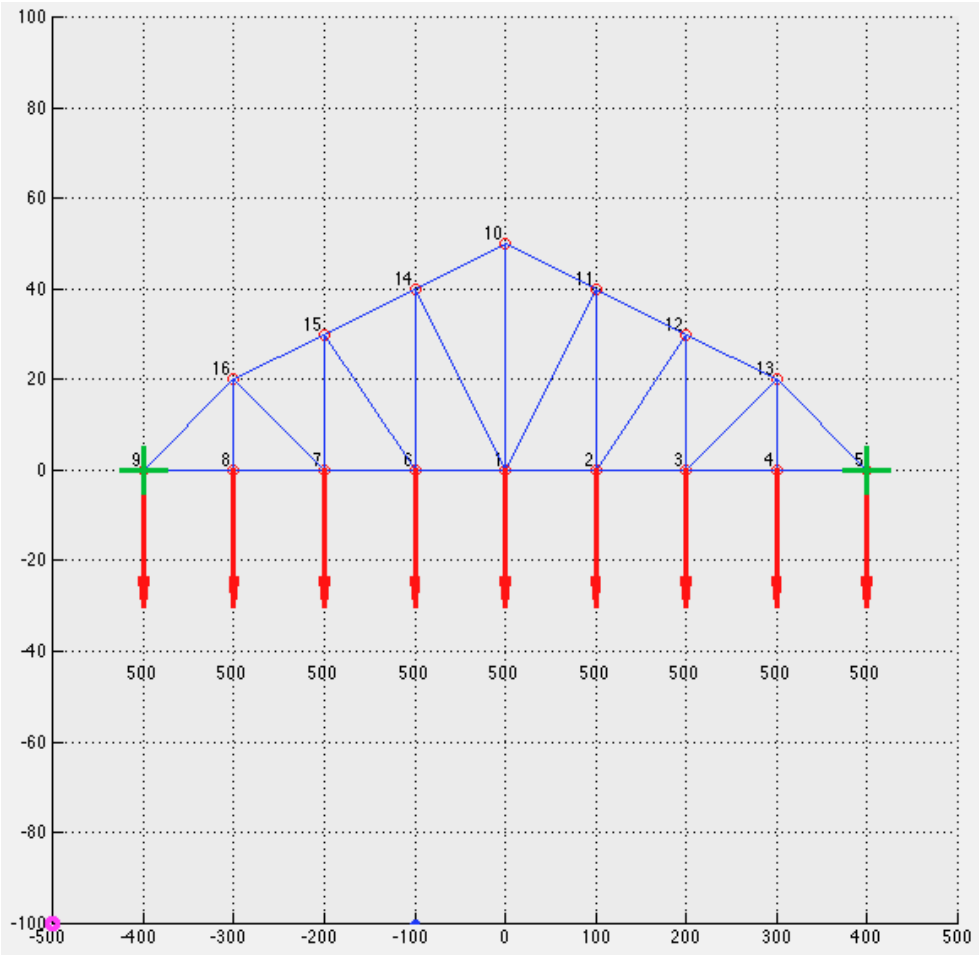

Figure 1

For instructions on how to use ***CADApps***, refer to the help menu included in the app. Also, you can view the following detailed video tutorials:

- Truss Application Overview: https://www.youtube.com/watch?v=hbRUwAYC-J8
- Example Truss Problem Tutorial: https://www.youtube.com/watch?v=aO848O-jkYg

1.3 Example Output

You will write a script called **project1.m** and when it is executed in Matlab, it must generate the following output.

Text output to the Command Window

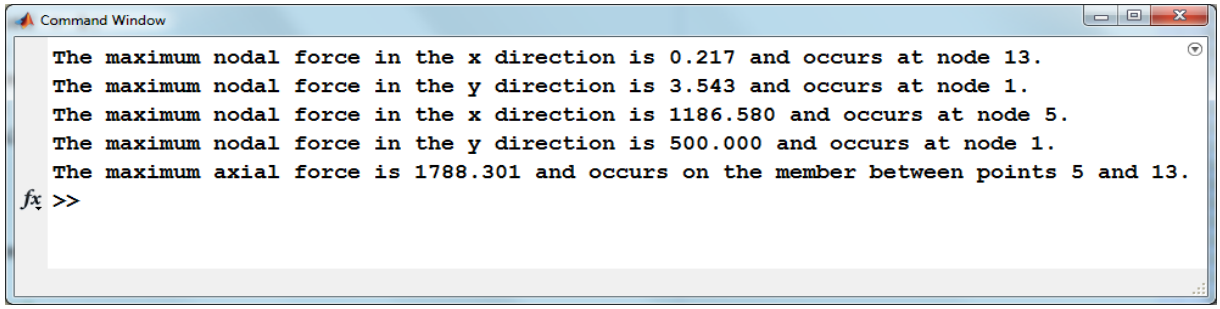

Figure 2

And the following two plots:

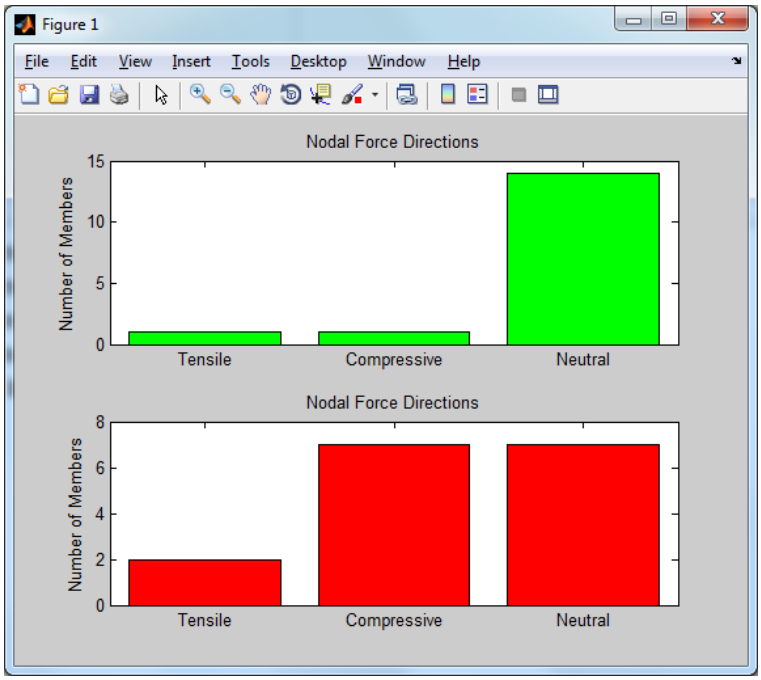

Figure 3

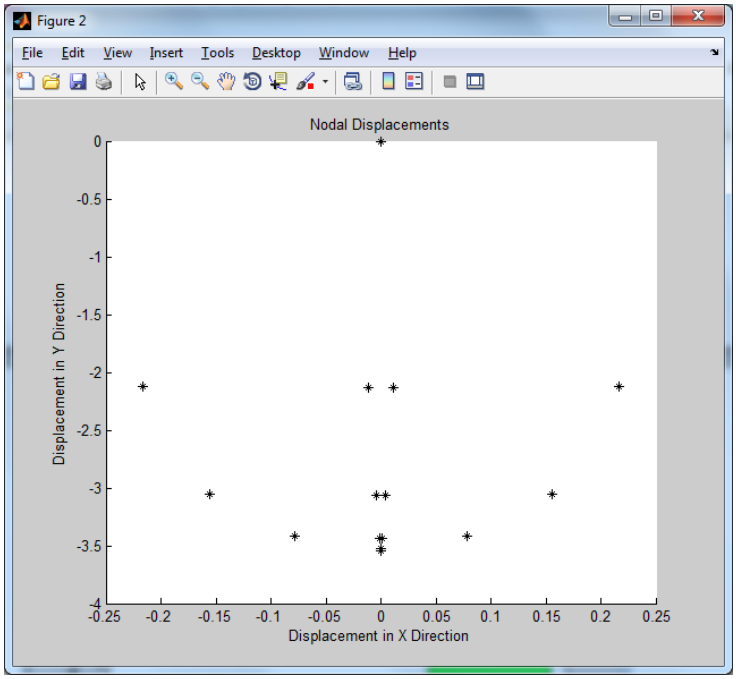

Figure 4

2 Design

2.1 CADApps Work

2.1.1 Create the truss in CADApps

Create the truss shown in Figure 1 using ***CADApps***. The following lists of nodes and members can be used for clarification of the truss design. When setting the Load, note the values of the forces and at what nodes they are applied. When setting the Boundary Conditions, note that Node 9 and 5 are pinned and the rest of the nodes of this truss are free. Also, note that for the members the cross-sectional area A varies.

#	X (m)	Y (m)	FX (N)	FY (N)
1	0	0	0	-500
2	100	0	0	-500
3	200	0	0	-500
4	300	0	0	-500
5	400	0	0	-500
6	-100	0	0	-500
7	-200	0	0	-500
8	-300	0	0	-500
9	-400	0	0	-500
10	0	50	0	0
11	100	40	0	0
12	200	30	0	0
13	300	20	0	0
14	-100	40	0	0
15	-200	30	0	0
16	-300	20	0	0

Member Properties

1	2	A (m^2)	E (N/m^2)(10^6)
1	2	5	1
2	3	5	1
3	4	5	1
4	5	5	1
5	13	1	1
12	13	1	1
11	12	1	1
10	11	1	1
10	14	1	1
14	15	1	1
15	16	1	1
9	16	1	1
8	9	5	1
7	8	5	1
6	7	5	1
1	6	5	1
7	16	1	1
6	15	1	1
1	14	1	1
1	10	1	1
1	11	1	1
2	12	1	1
3	13	1	1
4	13	1	1
3	12	1	1
2	11	1	1
6	14	1	1
7	15	1	1
8	16	1	1

2.1.2 Export the data about the truss from CADApps

Once you have created the desired truss in ***CADApps***, click on the **Run Simulation** button inside the app and see what happens to this truss under the specified loads and boundary conditions. In the Results Window of ***CADApps***, click on the **Export Results** button and save the results into a file called **truss.csv**. A .csv file is a Comma-Separated Values file where the values are stored in tabular form and separated by commas. A .csv file can be opened and read with Microsoft Excel or any text editor.
The Matlab script that you will write will use the data file **truss.csv**. This csv file will differ depending on the truss, but the process by which output results are generated will remain the same. The format of the .csv file is:

For the nodes:
Column A: Node number
Column B: Pre-Run X location
Column C: Pre-Run Y location
Column D: Post-Run X location
Column E: Post-Run Y location
Column F: Displacement in X Direction
Column G: Displacement in Y Direction
Column H: Force in X Direction
Column I: Force in Y Direction

For the members:
Columns A: Node 1 for a member
Columns B: Node 2 for a member
Column C: Axial force on a member

2.2 MATLAB Work

Now write a MATLAB script named **project1.m** that does the following.

2.2.1 Load the Data into MATLAB

Load the file ***truss.csv*** into MATLAB. For this you will need to use the built-in command `csvread`.

Once loaded into MATLAB, the data should be manipulated so that useful results can be printed to the Command Window. You need to complete the following steps:

a) Create a matrix of only the nodes and their associated values. This matrix should contain the node number, the displacement in the x and y directions, and the forces in the x and y directions. Each row of this matrix should contain the data for a separate node.
b) Create a matrix of only the members and their associated values. This matrix should contain the node numbers for that member and the axial forces. Each row of this matrix should contain the data for a separate member.

2.2.2 Manipulating the Data

Using the matrices that you created, find the following values and print the results to the Command Window as shown in Figure 2:

a) Find the maximum *nodal displacement* in both the x and y directions. Additionally, identify which nodes these values occur at.
b) Find the maximum *nodal force* in both the x and y directions. Additionally, identify which nodes these forces are acting upon.
c) Find the maximum axial force on a member. Additionally, identify which member this force is acting upon.

2.2.3 Plotting

Next, your code should generate the following plots:

a) A plot as in Figure 3 that contains two subplots.
In the first subplot is a bar graph that displays the number of x-axis nodal forces in the compressive, tensile, or neutral directions.

In the second subplot is a bar graph that displays the number of y-axis nodal forces in the compressive, tensile, or neutral directions.

If a force is positive then it is tensile, if it is negative then it is compressive and if it is zero then it is neutral.

Each subplot must be formatted with the colors, titles, and axes labels exactly as shown in the example output.

b) A plot as in Figure 4 that contains a scatter plot of the x and y displacements of each node. This plot must be formatted with the colors, titles, and axes labels as shown in the example output.

3 Styling Directions:

For this assignment you will create one m-file called project1.m . At the top add:

```
% Name (s) (of both students if working in a group!)
% Date
% Lab Section #
% Project 1: Truss Evaluation Project
% Description of Assignment
```

Make sure that you suppress all *unnecessary* output in your script.

4 Submission

This project will be **due Monday, September 22nd, 2014 at 2:00pm (one hour before lecture).**

Before you submit your work, make sure the program:

- behaves as specified in this document. Consider what will be the output of each step.
- is thoroughly tested.
- satisfies the grade sheet for this project

4.1 Online Submission.

You need to submit through the course's Moodle site. The name of the assignment is **Project 1 Submission.** Only one student per group needs to submit their assignment via Moodle. Make sure that you have both students name in the comments of your file.
You need to submit **two** files:

- project1.m
- truss.csv

4.2 Hard Copy Submission – due at the beginning of lecture on September 22, 2014

- Print your **project1.m** file and **truss.csv** file. Matlab .m files are text files so you can use any text editor to print them
- Also, print the **grading sheet** (last page of this document) and fill in your name(s), NCSU email, and Lab Section number.
- **Staple** your grade sheet **on top** followed by your other printed files.

Only one hard copy submission per group is required.

The hard copies will be collected at the beginning of lecture. If your hard copy is late (i.e., not submitted when collected), you will receive a -5 pt. grade deduction.

4.3 Early Submissions

Early submissions will receive a specific amount of extra credit points on the assignment depending on the date in which they were submitted. *Note that no grade above 100 will be given.* The points given are as follows:

- Submissions by 11:55pm on 9/8/2014 receive 10 points extra credit
- Submissions by 11:55pm on 9/15/2014 receive 5 points extra credit

Grade Sheet

Student 1:
Name : _____
NCSU Email: _____ Lab Section #: _____

Student 2:
Name : _____
NCSU Email: _____ Lab Section #: _____

Points	Earned	Description
Comments:		
0.5		Name, date, section, etc. in project header
0.5		Correctly named script file (**project1.m**)
5		Code is well-commented
4		Code is cell blocked
CADApps Work		
5		**truss.csv** file generated and submitted properly
Input		
15		Correctly importing and separating into matrices from **truss.csv** into Matlab
Matrix Manipulation		
20		Correctly finding x and y displacements AND printing
15		Correctly finding axial forces on members AND printing
Plot Generation		
25		Plot 1 generated and correctly annotated
15		Plot 2 generated and correctly annotated

Points	Deducted	Description
-5		Hardcopy turned in late, not stapled, or grade sheet improperly filled out.

Total Points Possible	Total Points Earned
100	

Graded by: _____