SE 143B Team Airbenders MATLAB Code User Manual

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Contents

1 Cell Homogenous Analysis

Step #1

In order to run the necessary 1 Cell Homogenous test case the user will need to open the 'SE143A UAV-CSA INPUT.xlsx' file within the file directory of the submitted code. Please be in the Excel Sheet labeled 'Team (B)'. Once the file is opened, it should look like the file below.

UAV Composite Structural Analysis - Team (B) Input

SE-143B Design of Composite Structures, University of California, San Diego (Copyright J.B. Kosmatka, 2020)

X	Project 1:	Additional Input										
Ply #	1	2	3	4	5	6	7	8	9	10	11	12
CompID1 (Material ID)	7	7	7									
CompID2 (Material ID)	7	7	7	4	4	4						
CompID3 (Material ID)	4	4										
CompID4 (Material ID)	7	7	7									
CompID5 (Material ID)	1	1	1	1	1	1	1	1				
CompID6 (Material ID)	1	1	1	1	1	1	1	1				
CompID7 (Material ID)	1	1	1	1	1	1	1	1				
CompID8 (Material ID)	1	1	1	1	1	1	1	1				
CompID9 (Material ID)	1	1	1	1	1	1	1	1				
CompID10 (Material ID)	1	1	1	1	1	1	1	1				
CompID11(Material ID)	1	1	1	1	1	1	1	1				
THICKNESSID1	0.0085	0.0085	0.0085									
THICKNESSID2	0.0085	0.0085	0.0085	0.012	0.012	0.012						
THICKNESSID3	0.012	0.012										
THICKNESSID4	0.0085	0.0085	0.0085									
THICKNESSID5	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID6	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID7	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID8	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID9	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID10	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID11	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001		x		
RotationID1	45	45	45									
RotationID2	45	45	45	0	45	0						
RotationID3	45	45										
RotationID4	45	45	45									
RotationID5	0	0	0	0	0	0	0	0				
RotationID6	0	0	0	0	0	0	0	0				
RotationID7	0	0	0	0	0	0	0	0				
RotationID8	0	0	0	0	0	0	0	0				
RotationID9	0	0	0	0	0	0	0	0				
RotationID10	0	0	0	0	0	0	0	0				
RotationID11	0	0	0	0	0	0	0	0				
Number of PliesID1	3											
Number of PliesID2	6											
Number of PliesID3	2											
Number of PliesID4	3											
Number of PliesID5	8											
Number of PliesID6	8											
Number of PliesID7	8											
Number of PliesID8	8											

Step #2

The user should proceed to the section of the file corresponding to heading 'Project 2: Validation Studies Input'. In order to ensure that 1 Cell Homogenous Analysis is being analyzed, be sure to input a value of 1 to the corresponding 'Test Case Input Flag' as shown here.

X	Project 2:
Test Case Input Flag	1
1 Cell Isotropic	1
1 Cell Composite	2
2 Cell Isotropic	3
2 Cell Composite	4
3 Cell Wing	5

Step #3

Beside this ‘Input Flag’ identifier, here is where applied tip loading, uniformly distributed loads, or linearly distributed loads can be assigned for this 1 Cell Analysis as shown below.

Linearly Distributed Loads, Specifies Max Value at Root			
p_x	Distributed Force x-	0	lb/in
p_y	Distributed Force y-	0	lb/in
p_z	Distributed Force z-	0	lb/in
m_x	Distributed Torque	0	lb-in/in
m_y	Distributed Momen	0	lb-in/in
m_z	Distributed Momen	0	lb-in/in

Applied Tip Loading			
Px	Applied Force x-dr	0	lb
Py	Applied Force y-di	0	lb
Pz	Applied Force z-di	0	lb
Mx	Applied Torque x-(	0	lb/in
My	Applied Moment y	0	lb/in
Mz	Applied Moment z	0	lb/in

Uniformly Distributed Loads			
p_x	Distributed Fo	0	lb/in
p_y	Distributed Fo	0	lb/in
p_z	Distributed Fo	8	lb/in
m_x	Distributed To	0	lb-in/in
m_y	Distributed Mc	0	lb-in/in
m_z	Distributed Mc	0	lb-in/in

Step #4

After providing the above input, proceed to the section ‘1) cantilever beam with thin-wall 1-cell rectangular cross-section - isotropic’, it should look like the image seen here. In this section, make sure the white cells in the region seen here are populated with 11.0 values.

Test Case 1	Stringer ID (from Database)	
Station (x/c) - PREFERRED	y (upper)	y (lower)
0.000		
0.010		
0.025		
0.050		
0.100		
0.150	11.000	11.000
0.250	11.000	11.000
0.350		
0.500		
0.650	11.000	11.000
0.800	11.000	11.000
1.000		

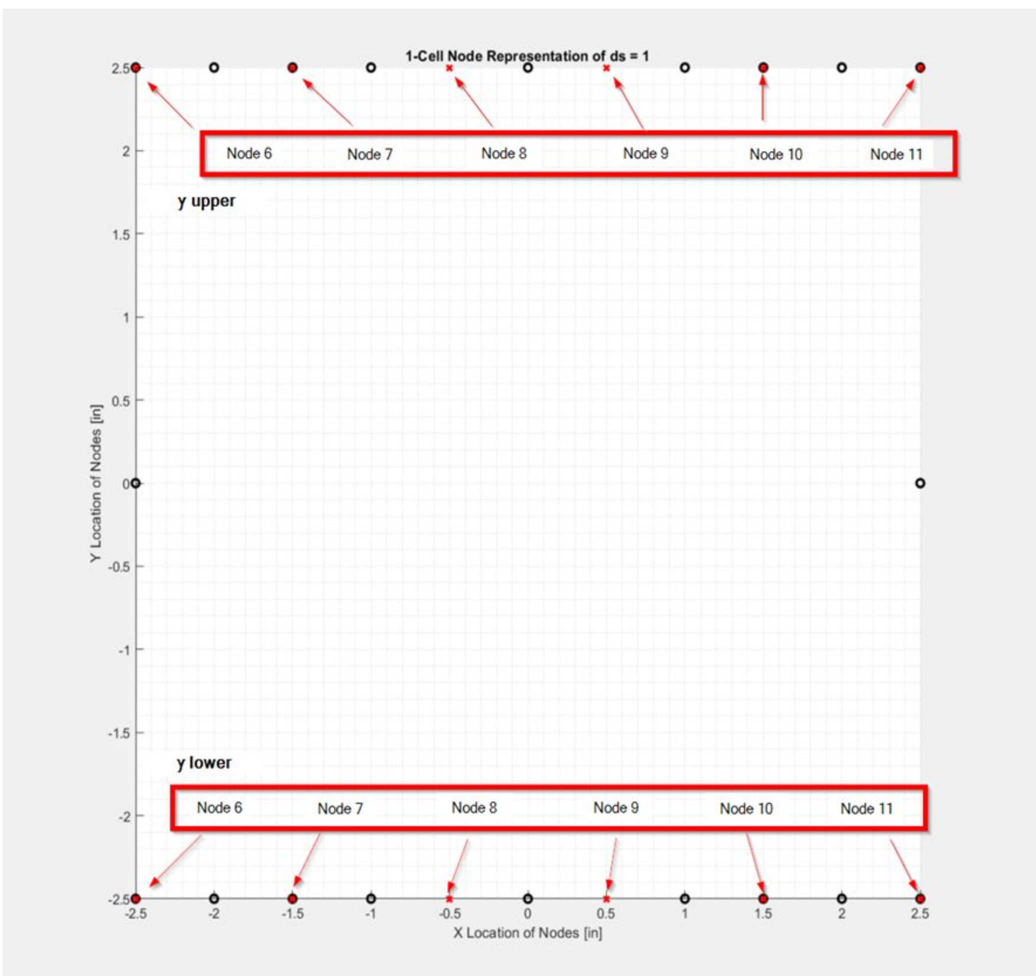
This corresponds to how the bending and shear flow analysis is conducted and is necessary for the code to run.

Step #5

To the right of the previous table, here is where the user can define the geometry needed for 1 Cell Analysis, the blacked out cells should not have any input.

Test Cases (1 Cell)					
Node Location	x (inches)	y (inches)	Node Location	x (inches)	y (inches)
1			7	-1.5	-2.5
2			8	-0.5	-2.5
3			9	0.5	-2.5
4			10	1.5	-2.5
5			11	2.5	-2.5
6	-2.5	-2.5	12		

Also, it is assumed that the user inputs the node locations corresponding to an origin defined at the geometric center for 1 Cell Analysis. This is highlighted with a reference of a 1 Cell example further to the right of the table shown above. Please note that these nodes correspond only to the lower half of the geometry. The MATLAB Code will then mirror them about the y = 0 axis.



Step #6

Below the user defined node locations, is a table where the user can define the material properties required for analysis, as seen here.

Test Case 1	in ID (from Database)	
Skin Connectivity	y (upper)	y (lower)
node 1 to node 2		
node 2 to node 3		
node 3 to node 4		
node 4 to node 5		
node 5 to node 6		
node 6 to node 7	1	1
node 7 to node 8	1	1
node 8 to node 9	1	1
node 9 to node 10	1	1
node 10 to node 1	1	1
node 11 to node 1		

Spar	ID
Fwd Vertical Box	1
Vertical Shear W	
Bck Vertical Box \	1
Struct Box Wall (nc	1

Because this is an isotropic analysis, only input one material ID to all the corresponding cells. Also, for the spar ID's only the 'Fwd Vertical Box' and 'Struct Box Wall' ID's are used, but all 4 cells need input to run the code.

Step #7

After assigning the material ID, scroll back up to right above the section 'Project 2: Validation Studies Input'. The section should look similar to the picture below.

WING SKIN DATA BASE				
Variable	**Description**	**Units**	**ID: 1**	**ID: 2**
t	thickness	inch or mm	0.040	
E	Young's Mod	Msi or Gpa	1.700	
G	Shear Modu	Msi or Gpa	1.079	
σ^{*}_{T}	Allowable St	Ksi or Mpa	3.8	
σ^{*}_{c}	Allowable St	Ksi or Mpa	-60	
σ^{*}_{s}	Allowable St	Ksi or Mpa	8.6	
ρ	Density	lb/in3 or gm/in3	0.023	

Make sure that only ID:1 values are populated to material properties that the user would like to define as seen in the above table. Also, make sure to populate ID:11 values to be zero, this is needed for how the code is written. Therefore, ID:11 should look like this.

ID: 7	ID: 8	ID: 9	ID: 10	ID: 11
				0.000
				0.000
				0.000
				0
				0
				0
				0

Step #8

After all the inputs have been assigned to the Excel sheet 'Team (B)', please go to the Excel sheet within the same workbook labeled 'Input'. The file should look like the figure below.

UAV Composite Structural Analysis - MATLAB (UAV-CSA)

SE-143A Design of Composite Structures, University of California, San Diego (Copyright J.B. Kosmatka, 2020)

Version: Winter, 2020 (v4)

Project Title: UCSD Sterna UAV Test Case

Variable	Description	Value	Units
Input	Input Units	1	1 = US, 2 = SI
Output	Output Units	1	1 = US, 2 = SI

X Project 1: Aircraft Performance - Calculation of Aircraft Performance, Weight and V-n Diagram

1.a) Aircraft Aerodynamic Definition

Variable	Description	Value	Units
$dC_L/d\alpha$	Lift Curve Slope	0.113	1/degree
α_0	Zero Lift Angle	-2.2	degree
$C_{L\,max}$ (+)	Max Lift at Stall (+)	1.4	1
α_{stall} (+)	Stall Angle (+)	10.2	degree
$C_{L\,max}$ (-)	Max Lift at Stall (-)	-1.4	1
α_{stall} (-)	Stall Angle (-)	-14.6	degree
C_{m}	Wing Moment Coefficient	-0.095	1
$C_{D0,F}$	Parasitic Drag - Fuselage	0.017	1
$C_{D0,W}$	Parasitic Drag - Wing	0.011	1
$C_{Di,W}$	Induced Drag Coefficient	0.0226	1
d_0	Spanwise drag amplification	1	1
d_{1}	Spanwise drag amplification	0.2	1
Hp	Maximum Motor Power	5	Hp or Watts
η	Propeller Efficiency	85	%

Do not worry about the input in any of the cells except the ones talked about in the following steps, as the code does not read these cells for this 1 Cell Analysis.

Step #9

Scroll down to the cell 'E83', this is where you will define the beam length for this analysis. The units will correspond to inches as this analysis is done in the English system.

L	Wing-Structural Length	60	inch or m

Step #10

Scroll down to cell 'E:153', this is where the number of cross sections are accounted for. Enter the desired refinement in the cell given below.

Variable	Description	Value	Units
dx	discretize wing length	80	1

Step #11

Scroll down to cell 'E:188', this is where the number of subdivisions of each wing segment (corresponding to the node locations specified earlier) can be defined.

Variable	Description	Value	Units
ds	subdivide each wing skin segme	10	1

Step #12

Finally, save and close the file 'SE143A UAV-CSA INPUT (v4).xlsx' and open up the MATLAB file labeled 'SE143A_WingAnalysisCode_vGJnCo.m'. The file pop-up screen should be similar to the one seen below.

```
% . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
% .
% .  SE-143B: Aerostructures Senior Capstone II
% .
% .  Title:   Bending Stress Analysis
% .  Author:  Team Airbenders
% .  Revised: 4/22/2020
% .
% .  Input  File: SE143A UAV-CSA INPUT (v4).xlsx
% .               2020 03 09 Wing Planform.xlsx
% .
% .  Output File: SE143A UAV-CSA OUTPUT(v1).xlsx [sheet: 5]
% . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
clear all; close all; clc;

% Define Input and Output EXCEL Files near the top of (M) file
inFile   = 'SE143A UAV-CSA INPUT (v4).xlsx';
inFilePlanform = '2020 03 09 Wing Planform.xlsx';

outFile = 'SE143A UAV CSA OUTPUT (v1).xlsx';


%%
% . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
% .  Section 1: Take input from Excel File
% . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
```

Simply, run the code using the 'Run' button in the 'Editor' section of the 'Toolstrip'.

Step #13

To view results, open up the Excel file 'SE143A UAV CSA OUTPUT (v1)'. The first few sheets will not be populated as those belong to the Wing Analysis portion of the code, but the following sheets will be populated with figures depicting the analysis conclusions: '3) Wing Definition', '4) Shear Moment Diagrams', '5) Wing Bending', '6) Wing Shear'.

1 Cell Composite Analysis

<u>Step #1</u>

In order to run the necessary 1 Cell Composite test case the user will need to open the ‘SE143A UAV-CSA INPUT.xlsx’ file within the file directory of the submitted code. Please be in the Excel Sheet labeled ‘Team (B)’. Once the file is opened, it should look like the file below.

UAV Composite Structural Analysis - Team (B) Input

SE-143B Design of Composite Structures, University of California, San Diego (Copyright J.B. Kosmatka, 2020)

X	Project 1:	Additional Input										
Ply #	1	2	3	4	5	6	7	8	9	10	11	12
CompID1 (Material ID)	7	7	7									
CompID2 (Material ID)	7	7	7	4	4	4						
CompID3 (Material ID)	4	4										
CompID4 (Material ID)	7	7	7									
CompID5 (Material ID)	1	1	1	1	1	1	1	1				
CompID6 (Material ID)	1	1	1	1	1	1	1	1				
CompID7 (Material ID)	1	1	1	1	1	1	1	1				
CompID8 (Material ID)	1	1	1	1	1	1	1	1				
CompID9 (Material ID)	1	1	1	1	1	1	1	1				
CompID10 (Material ID)	1	1	1	1	1	1	1	1				
CompID11(Material ID)	1	1	1	1	1	1	1	1				
THICKNESSID1	0.0085	0.0085	0.0085									
THICKNESSID2	0.0085	0.0085	0.0085	0.012	0.012	0.012						
THICKNESSID3	0.012	0.012										
THICKNESSID4	0.0085	0.0085	0.0085									
THICKNESSID5	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID6	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID7	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID8	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID9	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID10	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID11	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001		x		
RotationID1	45	45	45									
RotationID2	45	45	45	0	45	0						
RotationID3	45	45										
RotationID4	45	45	45									
RotationID5	0	0	0	0	0	0	0	0				
RotationID6	0	0	0	0	0	0	0	0				
RotationID7	0	0	0	0	0	0	0	0				
RotationID8	0	0	0	0	0	0	0	0				
RotationID9	0	0	0	0	0	0	0	0				
RotationID10	0	0	0	0	0	0	0	0				
RotationID11	0	0	0	0	0	0	0	0				
Number of PliesID1	3											
Number of PliesID2	6											
Number of PliesID3	2											
Number of PliesID4	3											
Number of PliesID5	8											
Number of PliesID6	8											
Number of PliesID7	8											
Number of PliesID8	8											

<u>Step #2</u>

The user should proceed to the section of the file corresponding to heading ‘Project 2: Validation Studies Input’. In order to ensure that 1 Cell Composite Analysis is being analyzed, be sure to input a value of 2 to the corresponding ‘Test Case Input Flag’ as shown here.

X	Project 2:
Test Case Input Flag	2
1 Cell Isotropic	1
1 Cell Composite	2
2 Cell Isotropic	3
2 Cell Composite	4
3 Cell Wing	5

Step #3

Beside this 'Input Flag' identifier, here is where applied tip loading, uniformly distributed loads, or linearly distributed loads can be assigned for this 1 Cell Analysis as shown below.

Linearly Distributed Loads, Specifies Max Value at Root			
p_x	Distributed Force x-	0	lb/in
p_y	Distributed Force y-	0	lb/in
p_z	Distributed Force z-	0	lb/in
m_x	Distributed Torque	0	lb-in/in
m_y	Distributed Momen	0	lb-in/in
m_z	Distributed Momen	0	lb-in/in

Applied Tip Loading			
Px	Applied Force x-dr	0	lb
Py	Applied Force y-di	0	lb
Pz	Applied Force z-di	0	lb
Mx	Applied Torque x-	0	lb/in
My	Applied Moment y	0	lb/in
Mz	Applied Moment z	0	lb/in

Uniformly Distributed Loads			
p_x	Distributed Fo	0	lb/in
p_y	Distributed Fo	0	lb/in
p_z	Distributed Fo	8	lb/in
m_x	Distributed To	0	lb-in/in
m_y	Distributed Mo	0	lb-in/in
m_z	Distributed Mo	0	lb-in/in

Step #4

After providing the above input, proceed to the section '2) cantilever beam with thin-wall 1-cell rectangular cross-section - laminated composite', it should look like the image seen here. In this section, make sure the white cells in the region seen here are populated with 11.0 values.

Test Case 1	Stringer ID (from Database)	
Station (x/c) - PREFERRED	y (upper)	y (lower)
0.000		
0.010		
0.025		
0.050		
0.100		
0.150	11.000	11.000
0.250	11.000	11.000
0.350		
0.500		
0.650	11.000	11.000
0.800	11.000	11.000
1.000		

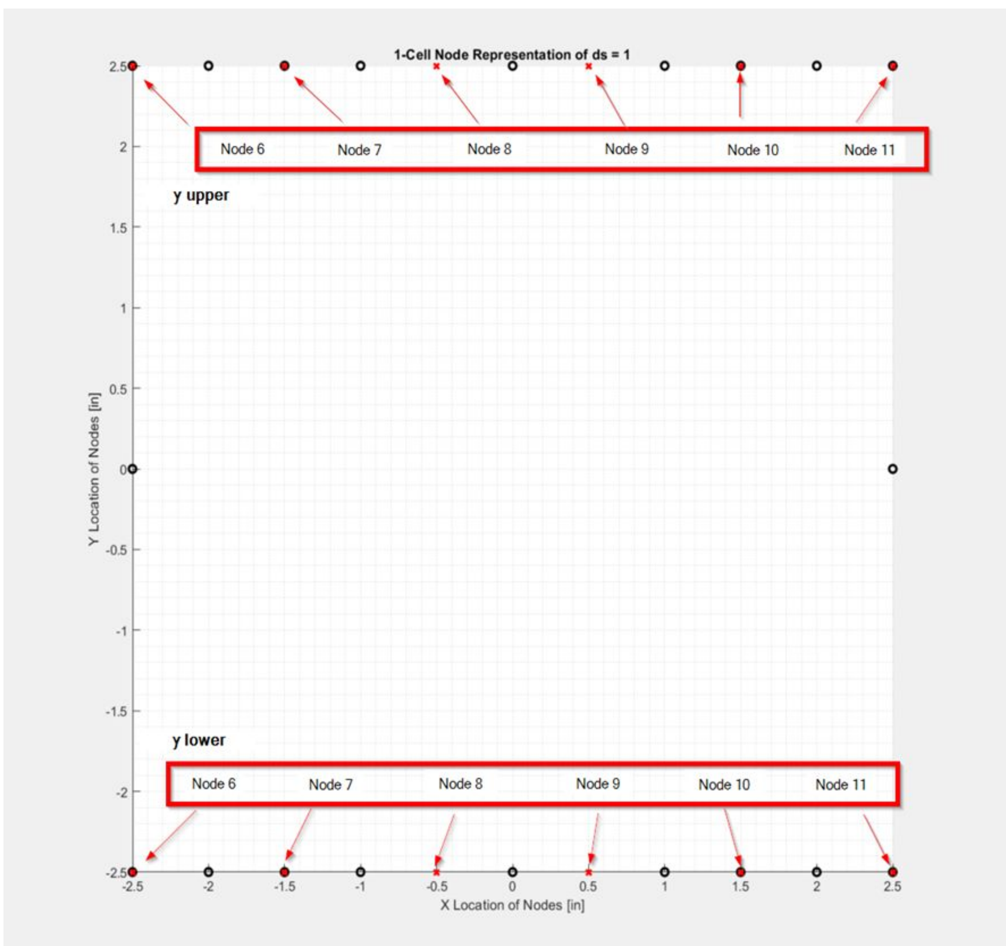
This corresponds to how the bending and shear flow analysis is conducted and is necessary for the code to run.

<u>Step #5</u>

To the right of the previous table, here is where the user can define the geometry needed for 1 Cell Analysis, the blacked out cells should not have any input.

Test Cases (1 Cell)					
Node Location	x (inches)	y (inches)	Node Location	x (inches)	y (inches)
1			7	-1.5	-2.5
2			8	-0.5	-2.5
3			9	0.5	-2.5
4			10	1.5	-2.5
5			11	2.5	-2.5
6	-2.5	-2.5	12		

Also, it is assumed that the user inputs the node locations corresponding to an origin defined at the geometric center for 1 Cell Analysis. This is highlighted with a reference of a 1 Cell example further to the right of the table shown above. Please note that these nodes correspond only to the lower half of the geometry. The MATLAB Code will then mirror them about the y = 0 axis.



Step #6

Below the user defined node locations, is a table where the user can define the material properties required for analysis, as seen here.

Test Case 1	in ID (from Database)	
Skin Connectivity	y (upper)	y (lower)
node 1 to node 2		
node 2 to node 3		
node 3 to node 4		
node 4 to node 5		
node 5 to node 6		
node 6 to node 7	4	4
node 7 to node 8	4	4
node 8 to node 9	6	7
node 9 to node 10	6	7
node 10 to node 1	8	9
node 11 to node 1		

Spar	ID
Fwd Vertical Box	5
Vertical Shear W	
Bck Vertical Box	1
Struct Box Wall (nc	2

Because this is a composite laminate analysis, various material ID's will be input here. Also, for the spar ID's only the 'Fwd Vertical Box' and 'Struct Box Wall' ID's are used, but all 4 cells need input to run the code.

Step #7

After assigning the material ID, scroll back up to the section 'Project 1: Additional Input'. The section should look similar to the first picture of the '1 Cell Analysis Composite Analysis' previously shown. This is where the user can define the unique laminate layups that will be used in their structure.

Step #8

Looking at the first region, as seen below

X	Project 1: Additional Input		
Ply #	1	2	3
CompID1 (Material ID)	7	7	7
CompID2 (Material ID)	7	7	7
CompID3 (Material ID)	4	4	
CompID4 (Material ID)	7	7	7
CompID5 (Material ID)	1	1	1
CompID6 (Material ID)	1	1	1
CompID7 (Material ID)	1	1	1
CompID8 (Material ID)	1	1	1
CompID9 (Material ID)	1	1	1
CompID10 (Material ID)	1	1	1
CompID11(Material ID)	1	1	1

This is where laminates are defined to a corresponding material ID. This corresponding material ID pertains to an ID in another Excel file. Please open the Excel file 'SE142_Material_DataBaseHK.xlsx'.

Step #9

The file should resemble the figure below.

Aerospace and Composite Material Data Base, Compiled by John Kosmatka
Updated: 11/10/2018

Reinforcement (Fiber) Properties Data Base

Variable	Description	Units	Carbon						
	Material ID Number		1	2	3	4	5	6	7
	Material Name:		AS4	T300	T800	IM6	IM7	High Modulus	Ultra Modulus
	Fiber Diameter	inch	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
E_{fL}	Young's Modulus (Longitudinal)	lb/in^2	33000000	33500000	34011300	36330000	40030000	53000000	70000000
E_{fT}	Young's Modulus (Transverse)	lb/in^2	2400000	2175000	2047900	2020000	2755700	1300000	1100000
G_{fLT}	Shear Modulus (L-T plane)	lb/in^2	3600000	4000000	2132000	7390000	3916000	2700000	2700000
G_{fTT}	Shear Modulus (T-T plane)	lb/in^2	1000000	1015000	930850	1200000	1015000	700000	700000
ν_{fLT}	Poisson ratio (L-T plane)		0.2	0.2	0.2462	0.26	0.2	0.2	0.2
ν_{fTT}	Poisson ratio (T-T plane)		0.2	0.2	0.1	0.33	0.2	0.25	0.25
ρ_f	Weight Density	lb/in^3	0.05	0.06358	0.06503	0.063	0.0643	0.068	0.072
α_{fL}	Thermal expansion coefficient (Longitidinal)	(in/in)/°F	-0.0000003	-0.0000004	-0.0000004	-0.000000566	-0.0000001	-0.00000055	-0.00000055
α_{fT}	Thermal expansion coefficient (Tranverse)	(in/in)/°F	0.0000083	0.0000067	0.0000067	0.0000018	0.0000056	0.0000056	0.0000056
K_{fL}	Heat Conduction (Longitudinal)	BTU/hr/ft^2/°F/in	580	580	580	580	600	600	600
K_{fT}	Heat Conduction (Transverse)	BTU/hr/ft^2/°F/in	58	58	58	58	60	60	60
F_{fT}	Tension strength	lb/in^2	570000	362590	362590	415000	751295	190000	150000
F_{fC}	Compression strength	lb/in^2	-400000	-290000	-290000	-367000	-464120	-170000	-150000
ε_{fT}	Tension Strain - Ultimate	in/in	0.0173	0.0109	0.0107	0.0115	0.0188	0.0036	0.0022
ε_{fC}	Compression Strain - Ultimate	in/in	-0.0122	-0.0087	-0.0086	-0.0102	-0.0116	-0.0033	-0.0022
	Reference								

Please scroll down to the section labeled 'Orthotropic Lamina Properties-Unidirectional and Fabrics'.

Orthotropic Lamina Properties - Unidirectional and Fabrics

	Variable	Description	Units	Carbon/epoxy			
1		Material ID Number		1	2	3	4
2		Material Name:		uni (AS-4/3501-6)	uni (IM6/3501-6)	uni (IM7/977-3)	Woven (AGP370-5H/35
3	V_f	Fiber Volume Fraction		0.63	0.635	0.65	0.62
4	E_1	Young's Modulus (Longitudinal)	lb/in^2	21300000	23300000	27700000	11200000
5	E_2	Young's Modulus (Transverse)	lb/in^2	1500000	1395000	1440000	10900000
6	E_3	Young's Modulus (Out-of-Plane)	lb/in^2	1500000	1395000	1440000	2000000
7	G_{12}	Shear Modulus (1-2 plane)	lb/in^2	1000000	916000	1130000	940000
8	G_{13}	Shear Modulus (1-3 plane)	lb/in^2	1000000	916000	1130000	740000
9	G_{23}	Shear Modulus (2-3 plane)	lb/in^2	540000	520000	600000	590000
10	ν_{12}	Poisson Ratio (1-2 plane)		0.27	0.2965	0.35	0.06
11	ν_{13}	Poisson Ratio (1-3 plane)		0.27	0.2965	0.35	0.37
12	ν_{23}	Poisson Ratio (2-3 plane)		0.45	0.468	0.45	0.45

As can be seen there are material ID's underneath the heading 'Carbon/epoxy' to help designate which material corresponds to which ID's. The previously mentioned Excel file uses these ID's to designate what the material properties are for each lamina in a specific layup. Now we can go back to the 'SE143A UAV-CSA INPUT.xlsx' file to continue interpreting the inputs.

Step #10

Looking at the region below were we previously defined the layup materials that pertained to each lamina, we can see another region corresponding to thicknesses of each lamina of each layup, as seen here.

THICKNESSID1	0.0085	0.0085	0.0085
THICKNESSID2	0.0085	0.0085	0.0085
THICKNESSID3	0.012	0.012	
THICKNESSID4	0.0085	0.0085	0.0085
THICKNESSID5	0.001	0.001	0.001
THICKNESSID6	0.001	0.001	0.001
THICKNESSID7	0.001	0.001	0.001
THICKNESSID8	0.001	0.001	0.001
THICKNESSID9	0.001	0.001	0.001
THICKNESSID10	0.001	0.001	0.001
THICKNESSID11	0.001	0.001	0.001

Here the user can define what thickness each lamina for every layup will be.

Step #11

After defining the thickness of each lamina for each individual laminate, we can define the appropriate lamina orientation as well as seen down below.

RotationID1	45	45	45
RotationID2	45	45	45
RotationID3	45	45	
RotationID4	45	45	45
RotationID5	0	0	0
RotationID6	0	0	0
RotationID7	0	0	0
RotationID8	0	0	0
RotationID9	0	0	0
RotationID10	0	0	0
RotationID11	0	0	0

Step #12

Also, the laminate section of the 'SE 143A UAV-CSA INPUT.xlsx' requires the number of plies for each laminate definition to be defined as seen in the region here.

Number of PliesID1	3
Number of PliesID2	6
Number of PliesID3	2
Number of PliesID4	3
Number of PliesID5	8
Number of PliesID6	8
Number of PliesID7	8
Number of PliesID8	8
Number of PliesID9	8
Number of PliesID10	8
Number of PliesID11	8

Step #13

Lastly, it is **required** that every row of the laminate definition table is populated with values. All the columns do not have to be populated, as this corresponds to the amount of plies in each laminate definition. This can be seen in an example given here.

X	Project 1:
Ply #	1
CompID1 (Material ID)	7
CompID2 (Material ID)	7
CompID3 (Material ID)	4
CompID4 (Material ID)	7
CompID5 (Material ID)	1
CompID6 (Material ID)	1
CompID7 (Material ID)	1
CompID8 (Material ID)	1
CompID9 (Material ID)	1
CompID10 (Material ID)	1
CompID11(Material ID)	1
THICKNESSID1	0.0085
THICKNESSID2	0.0085
THICKNESSID3	0.012
THICKNESSID4	0.0085
THICKNESSID5	0.001
THICKNESSID6	0.001
THICKNESSID7	0.001
THICKNESSID8	0.001
THICKNESSID9	0.001
THICKNESSID10	0.001
THICKNESSID11	0.001
RotationID1	45
RotationID2	45
RotationID3	45
RotationID4	45
RotationID5	0
RotationID6	0
RotationID7	0
RotationID8	0
RotationID9	0
RotationID10	0
RotationID11	0
Number of PliesID1	3
Number of PliesID2	6
Number of PliesID3	2
Number of PliesID4	3
Number of PliesID5	8
Number of PliesID6	8
Number of PliesID7	8
Number of PliesID8	8
Number of PliesID9	8
Number of PliesID10	8
Number of PliesID11	8

Step #14

After all the inputs have been assigned to the Excel sheet ‘Team (B)’, please go to the Excel sheet within the same workbook labeled ‘Input’. The file should look like the figure below.

UAV Composite Structural Analysis - MATLAB (UAV-CSA)

SE-143A Design of Composite Structures, University of California, San Diego (Copyright J.B. Kosmatka, 2020)

Version: Winter, 2020 (v4)

Project Title: UCSD Sterna UAV Test Case

Variable	Description	Value	Units
Input	Input Units	1	1 = US, 2 = SI
Output	Output Units	1	1 = US, 2 = SI

X Project 1: Aircraft Performance - Calculation of Aircraft Performance, Weight, and V-n Diagram

1.a) Aircraft Aerodynamic Definition

Variable	Description	Value	Units
$dC_L/d\alpha$	Lift Curve Slope	0.113	1/degree
α_0	Zero Lift Angle	-2.2	degree
$C_{L,max}$ (+)	Max Lift at Stall (+)	1.4	1
α_{stall} (+)	Stall Angle (+)	10.2	degree
$C_{L,max}$ (-)	Max Lift at Stall (-)	-1.4	1
α_{stall} (-)	Stall Angle (-)	-14.6	degree
C_m	Wing Moment Coefficient	-0.095	1
$C_{D_0,f}$	Parasitic Drag - Fuselage	0.017	1
$C_{D_0,W}$	Parasitic Drag - Wing	0.011	1
$C_{Di,W}$	Induced Drag Coefficient	0.0226	1
d_0	Spanwise drag amplification	1	1
d_{1}	Spanwise drag amplification	0.2	1
Hp	Maximum Motor Power	5	Hp or Watts
η	Propeller Efficiency	85	%

Do not worry about the input in any of the cells except the ones talked about in the following steps, as the code does not read these cells for this 1 Cell Analysis.

Step #15

Scroll down to the cell ‘E83’, this is where you will define the beam length for this analysis. The units will correspond to inches as this analysis is done in the English system.

L	Wing-Structural Length	60	inch or m

Step #16

Scroll down to cell ‘E:153’, this is where the number of cross sections are accounted for. Enter the desired refinement in the cell given below.

Variable	Description	Value	Units
dx	discretize wing length	80	1

Step #17

Scroll down to cell 'E:188', this is where the number of subdivisions of each wing segment (corresponding to the node locations specified earlier) can be defined.

Variable	Description	Value	Units
ds	subdivide each wing skin segmer	10	1

Step #18

Finally, save and close the file 'SE143A UAV-CSA INPUT (v4).xlsx' and open up the MATLAB file labeled 'SE143A_WingAnalysisCode_vGJnCo.m'. The file pop-up screen should be similar to the one seen below.

```
% . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
% .
% .  SE-143B: Aerostructures Senior Capstone II
% .
% .  Title:   Bending Stress Analysis
% .  Author:  Team Airbenders
% .  Revised: 4/22/2020
% .
% .  Input  File: SE143A UAV-CSA INPUT (v4).xlsx
% .               2020 03 09 Wing Planform.xlsx
% .
% .  Output File: SE143A UAV-CSA OUTPUT(v1).xlsx [sheet: 5]
% . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
clear all; close all; clc;

% Define Input and Output EXCEL Files near the top of (M) file
inFile  = 'SE143A UAV-CSA INPUT (v4).xlsx';
inFilePlanform = '2020 03 09 Wing Planform.xlsx';

outFile = 'SE143A UAV CSA OUTPUT (v1).xlsx';


%%
% . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
% .  Section 1: Take input from Excel File
% . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
```

Simply, run the code using the 'Run' button in the 'Editor' section of the 'Toolstrip'.

Step #19

To view results, open up the Excel file 'SE143A UAV CSA OUTPUT (v1)'. The first few sheets will not be populated as those belong to the Wing Analysis portion of the code, but the following sheets will be populated with figures depicting the analysis conclusions: '3) Wing Definition', '4) Shear Moment Diagrams', '5) Wing Bending', '6) Wing Shear'.

2 Cell Homogenous Analysis

<u>Step #1</u>

In order to run the necessary 2 Cell Homogenous test case the user will need to open the 'SE143A UAV-CSA INPUT.xlsx' file within the file directory of the submitted code. Please be in the Excel Sheet labeled 'Team (B)'. Once the file is opened, it should look like the file below.

UAV Composite Structural Analysis - Team (B) Input

SE-143B Design of Composite Structures, University of California, San Diego (Copyright J.B. Kosmatka, 2020)

X	Project 1:	Additional Input										
Ply #	1	2	3	4	5	6	7	8	9	10	11	12
CompID1 (Material ID)	7	7	7									
CompID2 (Material ID)	7	7	7	4	4	4						
CompID3 (Material ID)	4	4										
CompID4 (Material ID)	7	7	7									
CompID5 (Material ID)	1	1	1	1	1	1	1	1				
CompID6 (Material ID)	1	1	1	1	1	1	1	1				
CompID7 (Material ID)	1	1	1	1	1	1	1	1				
CompID8 (Material ID)	1	1	1	1	1	1	1	1				
CompID9 (Material ID)	1	1	1	1	1	1	1	1				
CompID10 (Material ID)	1	1	1	1	1	1	1	1				
CompID11(Material ID)	1	1	1	1	1	1	1	1				
THICKNESSID1	0.0085	0.0085	0.0085									
THICKNESSID2	0.0085	0.0085	0.0085	0.012	0.012	0.012						
THICKNESSID3	0.012	0.012										
THICKNESSID4	0.0085	0.0085	0.0085									
THICKNESSID5	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID6	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID7	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID8	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID9	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID10	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID11	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001		x		
RotationID1	45	45	45									
RotationID2	45	45	45	0	45	0						
RotationID3	45	45										
RotationID4	45	45	45									
RotationID5	0	0	0	0	0	0	0	0				
RotationID6	0	0	0	0	0	0	0	0				
RotationID7	0	0	0	0	0	0	0	0				
RotationID8	0	0	0	0	0	0	0	0				
RotationID9	0	0	0	0	0	0	0	0				
RotationID10	0	0	0	0	0	0	0	0				
RotationID11	0	0	0	0	0	0	0	0				
Number of PliesID1	3											
Number of PliesID2	6											
Number of PliesID3	2											
Number of PliesID4	3											
Number of PliesID5	8											
Number of PliesID6	8											
Number of PliesID7	8											
Number of PliesID8	8											

<u>Step #2</u>

The user should proceed to the section of the file corresponding to heading 'Project 2: Validation Studies Input'. In order to ensure that 2 Cell Homogenous Analysis is being analyzed, be sure to input a value of 3 to the corresponding 'Test Case Input Flag' as shown here.

X	Project 2:
Test Case Input Flag	3
1 Cell Isotropic	1
1 Cell Composite	2
2 Cell Isotropic	3
2 Cell Composite	4
3 Cell Wing	5

Step #3

Beside this ‘Input Flag’ identifier, here is where applied tip loading, uniformly distributed loads, or linearly distributed loads can be assigned for this 2 Cell Analysis as shown below.

Linearly Distributed Loads, Specifies Max Value at Root			
p_x	Distributed Force x-	0	lb/in
p_y	Distributed Force y-	0	lb/in
p_z	Distributed Force z-	0	lb/in
m_x	Distributed Torque	0	lb-in/in
m_y	Distributed Momen	0	lb-in/in
m_z	Distributed Momen	0	lb-in/in

Applied Tip Loading			
Px	Applied Force x-dı	0	lb
Py	Applied Force y-di	0	lb
Pz	Applied Force z-di	0	lb
Mx	Applied Torque x-	0	lb/in
My	Applied Moment y	0	lb/in
Mz	Applied Moment z	0	lb/in

Uniformly Distributed Loads			
p_x	Distributed Fo	0	lb/in
p_y	Distributed Fo	0	lb/in
p_z	Distributed Fo	8	lb/in
m_x	Distributed To	0	lb-in/in
m_y	Distributed Mo	0	lb-in/in
m_z	Distributed Mo	0	lb-in/in

Step #4

After providing the above input, proceed to the section ‘3) cantilever beam with thin-wall 2-cell D-Section (ABAQUS comparison) - isotropic’, it should look like the image seen here. In this section, make sure the white cells in the region seen here are populated with 11.0 values.

TestCase 2	er ID (from Database)	
Station (x/c) - PREFERRED	y (upper)	y (lower)
0.000		
0.010	11.000	11.000
0.025		
0.050		
0.100		
0.150	11.000	11.000
0.250	11.000	11.000
0.350		
0.500		
0.650	11.000	11.000
0.800	11.000	11.000
1.000		

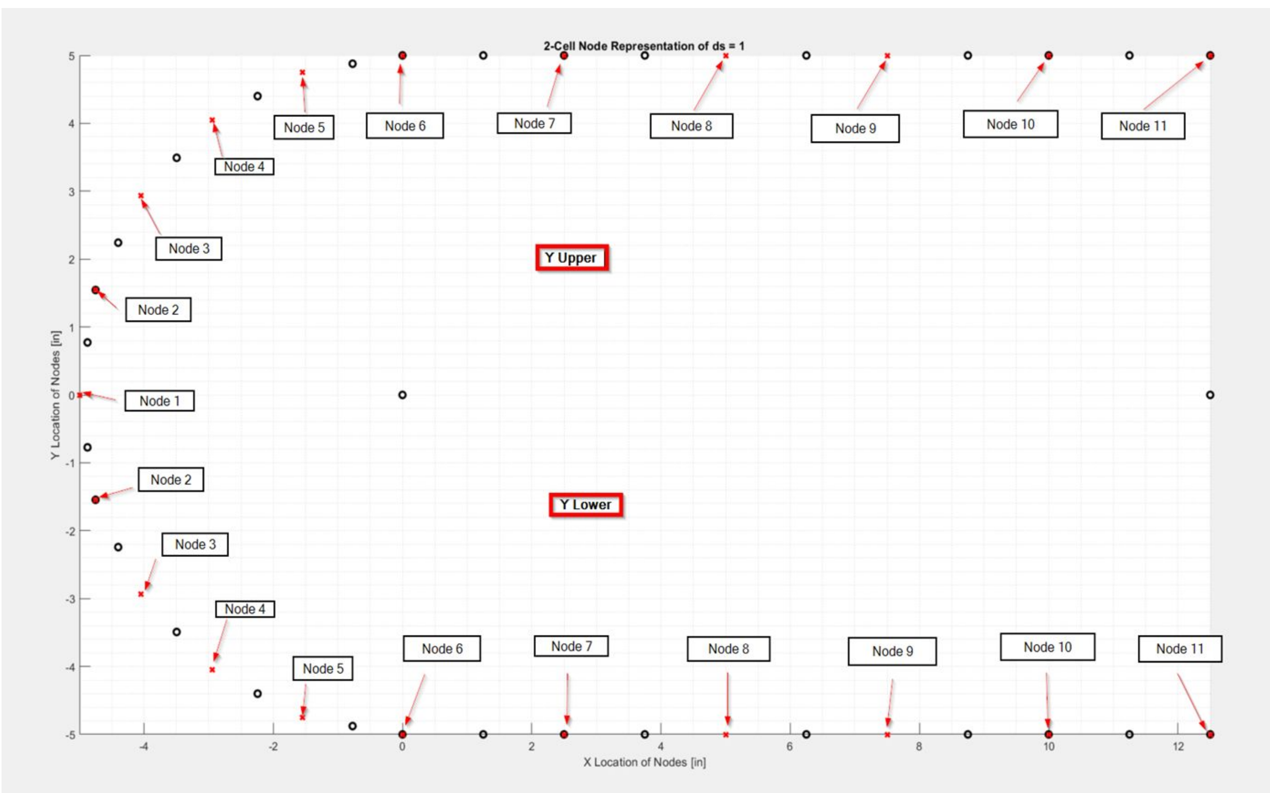
This corresponds to how the bending and shear flow analysis is conducted and is necessary for the code to run.

Step #5

To the right of the previous table, here is where the user can define the geometry needed for 2 Cell Analysis, the blacked out cells should not have any input.

Test Cases (2 Cell)					
Node Location	x (inches)	y (inches)	Node Location	x (inches)	y (inches)
1	-1.5	0	7	1	-1.5
2	-1.47	-0.3	8	4	-1.5
3	-1.22	-0.869	9	5	-1.5
4	-1	-1.1	10	7	-1.5
5	-0.6	-1.37	11	8	-1.5
6	0	-1.5	12		

Also, it is assumed that the user inputs the node locations corresponding to an origin defined at the radial definition for a semi-circle for 2 Cell Analysis. This is highlighted with a reference of a 2 Cell example further to the right of the table shown above. Please note that these nodes correspond only to the lower half of the geometry. The MATLAB Code will then mirror them about the y = 0 axis.



Step #6

Below the user defined node locations, is a table where the user can define the material properties required for analysis, as seen here.

Test Case 2	in ID (from Database)	
Skin Connectivity	y (upper)	y (lower)
node 1 to node 2	1	1
node 2 to node 3	1	1
node 3 to node 4	1	1
node 4 to node 5	1	1
node 5 to node 6	1	1
node 6 to node 7	1	1
node 7 to node 8	1	1
node 8 to node 9	1	1
node 9 to node 10	1	1
node 10 to node 1	1	1
node 11 to node 1		

Spar	ID
Fwd Vertical Box	1
Vertical Shear We	
Bck Vertical Box \	1
Struct Box Wall (nc	1

Because this is an isotropic analysis, only input one material ID to all the corresponding cells. Also, for the spar ID's only the 'Fwd Vertical Box' and 'Struct Box Wall' ID's are used, but all 4 cells need input to run the code.

Step #7

After assigning the material ID, scroll back up to right above the section 'Project 2: Validation Studies Input'. The section should look similar to the picture below.

WING SKIN DATA BASE				
Variable	**Description**	**Units**	**ID: 1**	**ID: 2**
t	thickness	inch or mm	0.040	
E	Young's Moc	Msi or Gpa	1.700	
G	Shear Modu	Msi or Gpa	1.079	
$\sigma^{\bullet}_{T}$	Allowable St	Ksi or Mpa	3.8	
$\sigma^{\bullet}_{C}$	Allowable St	Ksi or Mpa	-60	
$\sigma^{\bullet}_{S}$	Allowable St	Ksi or Mpa	8.6	
ρ	Density	lb/in3 or gm/in3	0.023	

Make sure that only ID:1 values are populated to material properties that the user would like to define as seen in the above table. Also, make sure to populate ID:11 values to be zero, this is needed for how the code is written. Therefore, ID:11 should look like this.

ID: 7	ID: 8	ID: 9	ID: 10	ID: 11
				0.000
				0.000
				0.000
				0
				0
				0
				0

Step #8

After all the inputs have been assigned to the Excel sheet 'Team (B)', please go to the Excel sheet within the same workbook labeled 'Input'. The file should look like the figure below.

UAV Composite Structural Analysis - MATLAB (UAV-CSA)

SE-143A Design of Composite Structures, University of California, San Diego (Copyright J.B. Kosmatka, 2020)

Version: Winter, 2020 (v4)

Project Title: UCSD Sterna UAV Test Case

Variable	Description	Value	Units
Input	Input Units	1	1 = US, 2 = SI
Output	Output Units	1	1 = US, 2 = SI

X Project 1: Aircraft Performance - Calculation of Aircraft Performance, Weight, and V-n Diagram

1.a) Aircraft Aerodynamic Definition

Variable	Description	Value	Units
$dC_L/d\alpha$	Lift Curve Slope	0.113	1/degree
α_0	Zero Lift Angle	-2.2	degree
$C_{L\,max}$ (+)	Max Lift at Stall (+)	1.4	1
α_{stall} (+)	Stall Angle (+)	10.2	degree
$C_{L\,max}$ (-)	Max Lift at Stall (-)	-1.4	1
α_{stall} (-)	Stall Angle (-)	-14.6	degree
C_m	Wing Moment Coefficient	-0.095	1
$C_{D0,f}$	Parasitic Drag - Fuselage	0.017	1
$C_{D0,W}$	Parasitic Drag - Wing	0.011	1
C_{DiW}	Induced Drag Coefficient	0.0226	1
d_0	Spanwise drag amplification	1	1
d_{i0}	Spanwise drag amplification	0.2	1
Hp	Maximum Motor Power	5	Hp or Watts
η	Propeller Efficiency	85	%

Do not worry about the input in any of the cells except the ones talked about in the following steps, as the code does not read these cells for this 2 Cell Analysis.

Step #9

Scroll down to the cell 'E83', this is where you will define the beam length for this analysis. The units will correspond to inches as this analysis is done in the English system.

L	Wing-Structural Length	60	inch or m

Step #10

Scroll down to cell ‘E:153’, this is where the number of cross sections are accounted for. Enter the desired refinement in the cell given below.

Variable	Description	Value	Units
dx	discretize wing length	80	1

Step #11

Scroll down to cell ‘E:188’, this is where the number of subdivisions of each wing segment (corresponding to the node locations specified earlier) can be defined.

Variable	Description	Value	Units
ds	subdivide each wing skin segme	10	1

Step #12

Finally, save and close the file ‘SE143A UAV-CSA INPUT (v4).xlsx’ and open up the MATLAB file labeled ‘SE143A_WingAnalysisCode_vGJnCo.m’. The file pop-up screen should be similar to the one seen below.

```
% . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
% .
% .  SE-143B: Aerostructures Senior Capstone II
% .
% .  Title:   Bending Stress Analysis
% .  Author:  Team Airbenders
% .  Revised: 4/22/2020
% .
% .  Input  File: SE143A UAV-CSA INPUT (v4).xlsx
% .               2020 03 09 Wing Planform.xlsx
% .
% .  Output File: SE143A UAV-CSA OUTPUT(v1).xlsx [sheet: 5]
% . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
clear all; close all; clc;

% Define Input and Output EXCEL Files near the top of (M) file
inFile  = 'SE143A UAV-CSA INPUT (v4).xlsx';
inFilePlanform = '2020 03 09 Wing Planform.xlsx';

outFile = 'SE143A UAV CSA OUTPUT (v1).xlsx';

%%
% . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
% .  Section 1: Take input from Excel File
% . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
```

Simply, run the code using the ‘Run’ button in the ‘Editor’ section of the ‘Toolstrip’.

Step #13

To view results, open up the Excel file ‘SE143A UAV CSA OUTPUT (v1)’. The first few sheets will not be populated as those belong to the Wing Analysis portion of the code, but the following sheets will be populated with figures depicting the analysis conclusions: ‘3) Wing Definition’, ‘4) Shear Moment Diagrams’, ‘5) Wing Bending’, ‘6) Wing Shear’.

2 Cell Composite Analysis

Step #1

In order to run the necessary 2 Cell Composite test case the user will need to open the ‘SE143A UAV-CSA INPUT.xlsx’ file within the file directory of the submitted code. Please be in the Excel Sheet labeled ‘Team (B)’. Once the file is opened, it should look like the file below.

UAV Composite Structural Analysis - Team (B) Input

SE-143B Design of Composite Structures, University of California, San Diego (Copyright J.B. Kosmatka, 2020)

X	Project 1:	Additional Input										
Ply #	1	2	3	4	5	6	7	8	9	10	11	12
CompID1 (Material ID)	7	7	7									
CompID2 (Material ID)	7	7	7	4	4	4						
CompID3 (Material ID)	4	4										
CompID4 (Material ID)	7	7	7									
CompID5 (Material ID)	1	1	1	1	1	1	1	1				
CompID6 (Material ID)	1	1	1	1	1	1	1	1				
CompID7 (Material ID)	1	1	1	1	1	1	1	1				
CompID8 (Material ID)	1	1	1	1	1	1	1	1				
CompID9 (Material ID)	1	1	1	1	1	1	1	1				
CompID10 (Material ID)	1	1	1	1	1	1	1	1				
CompID11(Material ID)	1	1	1	1	1	1	1	1				
THICKNESSID1	0.0085	0.0085	0.0085									
THICKNESSID2	0.0085	0.0085	0.0085	0.012	0.012	0.012						
THICKNESSID3	0.012	0.012										
THICKNESSID4	0.0085	0.0085	0.0085									
THICKNESSID5	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID6	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID7	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID8	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID9	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID10	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID11	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001		x		
RotationID1	45	45	45									
RotationID2	45	45	45	0	45	0						
RotationID3	45	45										
RotationID4	45	45	45									
RotationID5	0	0	0	0	0	0	0	0				
RotationID6	0	0	0	0	0	0	0	0				
RotationID7	0	0	0	0	0	0	0	0				
RotationID8	0	0	0	0	0	0	0	0				
RotationID9	0	0	0	0	0	0	0	0				
RotationID10	0	0	0	0	0	0	0	0				
RotationID11	0	0	0	0	0	0	0	0				
Number of PliesID1	3											
Number of PliesID2	6											
Number of PliesID3	2											
Number of PliesID4	3											
Number of PliesID5	8											
Number of PliesID6	8											
Number of PliesID7	8											
Number of PliesID8	8											

Step #2

The user should proceed to the section of the file corresponding to heading ‘Project 2: Validation Studies Input’. In order to ensure that 2 Cell Composite Analysis is being analyzed, be sure to input a value of 4 to the corresponding ‘Test Case Input Flag’ as shown here.

X	Project 2:
Test Case Input Flag	4
1 Cell Isotropic	1
1 Cell Composite	2
2 Cell Isotropic	3
2 Cell Composite	4
3 Cell Wing	5

Step #3

Besides this 'Input Flag' identifier, here is where applied tip loading, uniformly distributed loads, or linearly distributed loads can be assigned for this 2 Cell Analysis as shown below.

Linearly Distributed Loads, Specifies Max Value at Root			
p_x	Distributed Force x-	0	lb/in
p_y	Distributed Force y-	0	lb/in
p_z	Distributed Force z-	0	lb/in
m_x	Distributed Torque	0	lb-in/in
m_y	Distributed Momen	0	lb-in/in
m_z	Distributed Momen	0	lb-in/in

Applied Tip Loading			
Px	Applied Force x-dı	0	lb
Py	Applied Force y-di	0	lb
Pz	Applied Force z-di	0	lb
Mx	Applied Torque x-(	0	lb/in
My	Applied Moment y	0	lb/in
Mz	Applied Moment z	0	lb/in

Uniformly Distributed Loads			
p_x	Distributed Fo	0	lb/in
p_y	Distributed Fo	0	lb/in
p_z	Distributed Fo	8	lb/in
m_x	Distributed To	0	lb-in/in
m_y	Distributed Mc	0	lb-in/in
m_z	Distributed Mc	0	lb-in/in

Step #4

After providing the above input, proceed to the section '4) cantilever beam with thin-wall 2-cell D-Section (ABAQUS comparison) - laminated composite', it should look like the image seen here. In this section, make sure the white cells in the region seen here are populated with 11.0 values.

TestCase 2	er ID (from Database)	
Station (x/c) - PREFERRED	y (upper)	y (lower)
0.000		
0.010	11.000	11.000
0.025		
0.050		
0.100		
0.150	11.000	11.000
0.250	11.000	11.000
0.350		
0.500		
0.650	11.000	11.000
0.800	11.000	11.000
1.000		

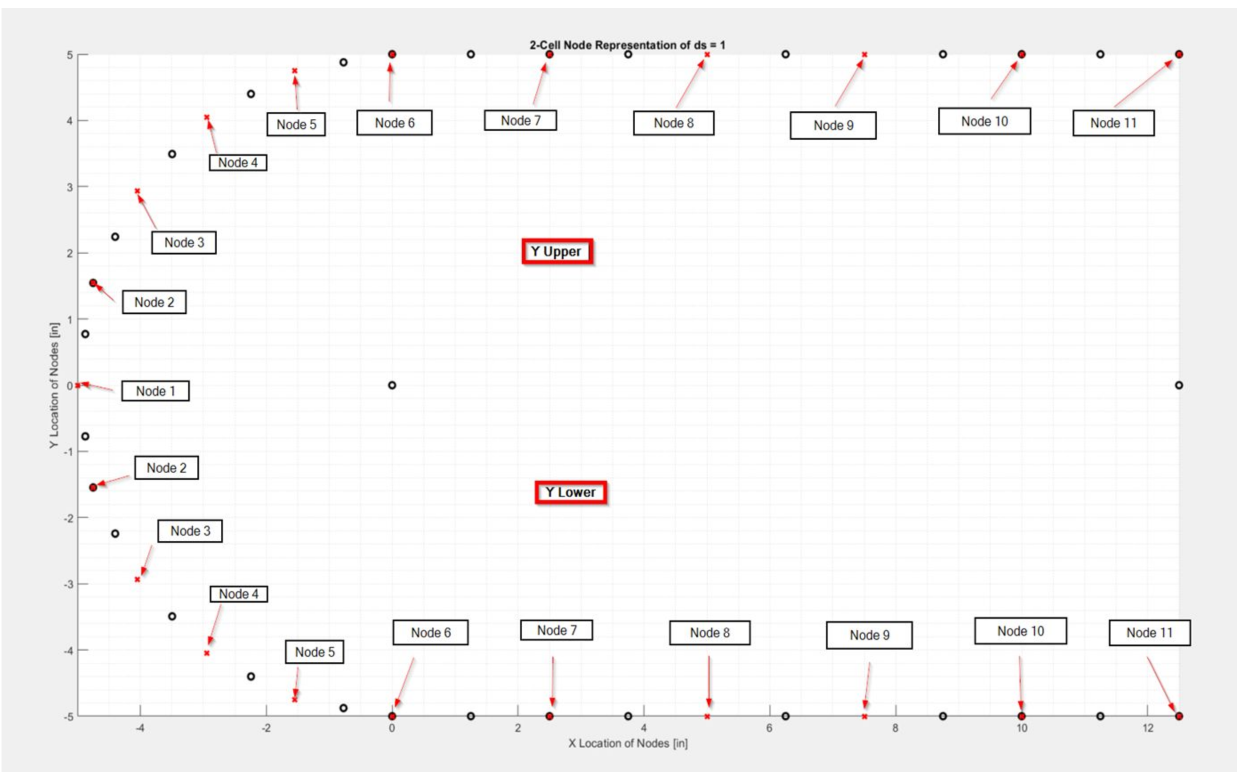
This corresponds to how the bending and shear flow analysis is conducted and is necessary for the code to run.

Step #5

To the right of the previous table, here is where the user can define the geometry needed for 2 Cell Analysis, the blacked out cells should not have any input.

Test Cases (2 Cell)					
Node Location	x (inches)	y (inches)	Node Location	x (inches)	y (inches)
1	-1.5	0	7	1	-1.5
2	-1.47	-0.3	8	4	-1.5
3	-1.22	-0.869	9	5	-1.5
4	-1	-1.1	10	7	-1.5
5	-0.6	-1.37	11	8	-1.5
6	0	-1.5	12		

Also, it is assumed that the user inputs the node locations corresponding to an origin defined at the radial definition for a semi-circle for 2 Cell Analysis. This is highlighted with a reference of a 2 Cell example further to the right of the table shown above. Please note that these nodes correspond only to the lower half of the geometry. The MATLAB Code will then mirror them about the y = 0 axis.



Step #6

Below the user defined node locations, is a table where the user can define the material properties required for analysis, as seen here.

Test Case 2	in ID (from Database)	
Skin Connectivity	y (upper)	y (lower)
node 1 to node 2	1	1
node 2 to node 3	1	1
node 3 to node 4	1	1
node 4 to node 5	1	1
node 5 to node 6	1	1
node 6 to node 7	2	2
node 7 to node 8	1	1
node 8 to node 9	1	1
node 9 to node 10	1	1
node 10 to node 1	2	2
node 11 to node 1	[redacted]	

Spar	ID
Fwd Vertical Box	3
Vertical Shear W	[redacted]
Bck Vertical Box	1
Struct Box Wall (n	3

Because this is a composite laminate analysis, various material ID's will be input here. Also, for the spar ID's only the 'Fwd Vertical Box' and 'Struct Box Wall' ID's are used, but all 4 cells need input to run the code.

Step #7

After assigning the material ID, scroll back up to the section 'Project 1: Validation Studies Input'. The section should look similar to the first picture of the '2 Cell Analysis Composite Analysis' previously shown. This is where the user can define the unique laminate layups that will be used in their structure.

Step #8

Looking at the first region, as seen below

X	Project 1: Additional Input		
Ply #	1	2	3
CompID1 (Material ID)	7	7	7
CompID2 (Material ID)	7	7	7
CompID3 (Material ID)	4	4	
CompID4 (Material ID)	7	7	7
CompID5 (Material ID)	1	1	1
CompID6 (Material ID)	1	1	1
CompID7 (Material ID)	1	1	1
CompID8 (Material ID)	1	1	1
CompID9 (Material ID)	1	1	1
CompID10 (Material ID)	1	1	1
CompID11(Material ID)	1	1	1

This is where laminates are defined to a corresponding material ID. This corresponding material ID pertains to an ID in another Excel file. Please open the Excel file 'SE142_Material_DataBaseHK.xlsx'.

Step #9

The file should resemble the figure below.

Aerospace and Composite Material Data Base, Compiled by John Kosmatka

Updated: 11/10/2018

Reinforcement (Fiber) Properties Data Base

Variable	Description	Units	Carbon						
	Material ID Number		1	2	3	4	5	6	7
	Material Name:		AS4	T300	T800	IM6	IM7	High Modulus	Ultra Modulus
	Fiber Diameter	inch	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
E_{fL}	Young's Modulus (Longitudinal)	lb/in^2	33000000	33500000	34011300	36330000	40030000	53000000	70000000
E_{fT}	Young's Modulus (Transverse)	lb/in^2	2400000	2175000	2047900	2020000	2755700	1300000	1100000
G_{fLT}	Shear Modulus (L-T plane)	lb/in^2	3600000	4000000	2132000	7390000	3916000	2700000	2700000
G_{fTT}	Shear Modulus (T-T plane)	lb/in^2	1000000	1015000	930850	1200000	1015000	700000	700000
ν_{fLT}	Poisson ratio (L-T plane)		0.2	0.2	0.2462	0.26	0.2	0.2	0.2
ν_{fTT}	Poisson ratio (T-T plane)		0.2	0.2	0.1	0.33	0.2	0.25	0.25
ρ_f	Weight Density	lb/in^3	0.05	0.06358	0.06503	0.063	0.0643	0.068	0.072
α_{fL}	Thermal expansion coefficient (Longitidinal)	(in/in)/°F	0.0000003	0.0000004	0.0000004	-0.000000566	0.0000001	0.00000055	0.00000055
α_{fT}	Thermal expansion coefficient (Tranverse)	(in/in)/°F	0.0000083	0.0000067	0.0000067	0.0000018	0.0000056	0.0000056	0.0000056
K_{fL}	Heat Conduction (Longitudinal)	BTU/hr/ft²/°F/in	580	580	580	580	600	600	600
K_{fT}	Heat Conduction (Transverse)	BTU/hr/ft²/°F/in	58	58	58	58	60	60	60
F_{fT}	Tension strength	lb/in^2	570000	362590	362590	415000	751295	190000	150000
F_{fC}	Compression strength	lb/in^2	400000	290000	290000	-367000	464120	170000	150000
ε_{fT}	Tension Strain - Ultimate	in/in	0.0173	0.0109	0.0107	0.0115	0.0188	0.0036	0.0022
ε_{fC}	Compression Strain - Ultimate	in/in	0.0122	0.0087	0.0086	0.0102	0.0116	0.0033	0.0022
	Reference								

Please scroll down to the section labeled 'Orthotropic Lamina Properties-Unidirectional and Fabrics'.

Orthotropic Lamina Properties - Unidirectional and Fabrics

	Variable	Description	Units	Carbon/epoxy			
1		Material ID Number		1	2	3	4
2		Material Name:		uni (AS-4/3501-6)	uni (IM6/3501-6)	uni (IM7/977-3)	Woven (AGP370-5H/35
3	V_f	Fiber Volume Fraction		0.63	0.635	0.65	0.62
4	E_1	Young's Modulus (Longitudinal)	lb/in^2	21300000	23300000	27700000	11200000
5	E_2	Young's Modulus (Transverse)	lb/in^2	1500000	1395000	1440000	10900000
6	E_3	Young's Modulus (Out-of-Plane)	lb/in^2	1500000	1395000	1440000	2000000
7	G_{12}	Shear Modulus (1-2 plane)	lb/in^2	1000000	916000	1130000	940000
8	G_{13}	Shear Modulus (1-3 plane)	lb/in^2	1000000	916000	1130000	740000
9	G_{23}	Shear Modulus (2-3 plane)	lb/in^2	540000	520000	600000	590000
10	ν_{12}	Poisson Ratio (1-2 plane)		0.27	0.2965	0.35	0.06
11	ν_{13}	Poisson Ratio (1-3 plane)		0.27	0.2965	0.35	0.37
12	ν_{23}	Poisson Ratio (2-3 plane)		0.45	0.468	0.45	0.45

As can be seen there are material ID's underneath the heading 'Carbon/epoxy' to help designate which material corresponds to which ID's. The previously mentioned Excel file uses these ID's to designate what the material properties are for each lamina in a specific layup. Now we can go back to the 'SE143A UAV-CSA INPUT.xlsx' file to continue interpreting the inputs.

Step #10

Looking at the region below were we previously defined the layup materials that pertained to each lamina, we can see another region corresponding to thicknesses of each lamina of each layup, as seen here.

THICKNESSID1	0.0085	0.0085	0.0085
THICKNESSID2	0.0085	0.0085	0.0085
THICKNESSID3	0.012	0.012	
THICKNESSID4	0.0085	0.0085	0.0085
THICKNESSID5	0.001	0.001	0.001
THICKNESSID6	0.001	0.001	0.001
THICKNESSID7	0.001	0.001	0.001
THICKNESSID8	0.001	0.001	0.001
THICKNESSID9	0.001	0.001	0.001
THICKNESSID10	0.001	0.001	0.001
THICKNESSID11	0.001	0.001	0.001

Here the user can define what thickness each lamina for every layup will be.

Step #11

After defining the thickness of each lamina for each individual laminate, we can define the appropriate lamina orientation as well as seen down below.

RotationID1	45	45	45
RotationID2	45	45	45
RotationID3	45	45	
RotationID4	45	45	45
RotationID5	0	0	0
RotationID6	0	0	0
RotationID7	0	0	0
RotationID8	0	0	0
RotationID9	0	0	0
RotationID10	0	0	0
RotationID11	0	0	0

Step #12

Also, the laminate section of the ‘SE 143A UAV-CSA INPUT.xlsx’ requires the number of plies for each laminate definition to be defined as seen in the region here.

Number of PliesID1	3
Number of PliesID2	6
Number of PliesID3	2
Number of PliesID4	3
Number of PliesID5	8
Number of PliesID6	8
Number of PliesID7	8
Number of PliesID8	8
Number of PliesID9	8
Number of PliesID10	8
Number of PliesID11	8

Step #13

Lastly, it is **required** that every row of the laminate definition table is populated with values. All the columns do not have to be populated, as this corresponds to the amount of plies in each laminate definition. This can be seen in an example given here.

X	Project 1:
Ply #	1
CompID1 (Material ID)	7
CompID2 (Material ID)	7
CompID3 (Material ID)	4
CompID4 (Material ID)	7
CompID5 (Material ID)	1
CompID6 (Material ID)	1
CompID7 (Material ID)	1
CompID8 (Material ID)	1
CompID9 (Material ID)	1
CompID10 (Material ID)	1
CompID11(Material ID)	1
THICKNESSID1	0.0085
THICKNESSID2	0.0085
THICKNESSID3	0.012
THICKNESSID4	0.0085
THICKNESSID5	0.001
THICKNESSID6	0.001
THICKNESSID7	0.001
THICKNESSID8	0.001
THICKNESSID9	0.001
THICKNESSID10	0.001
THICKNESSID11	0.001
RotationID1	45
RotationID2	45
RotationID3	45
RotationID4	45
RotationID5	0
RotationID6	0
RotationID7	0
RotationID8	0
RotationID9	0
RotationID10	0
RotationID11	0
Number of PliesID1	3
Number of PliesID2	6
Number of PliesID3	2
Number of PliesID4	3
Number of PliesID5	8
Number of PliesID6	8
Number of PliesID7	8
Number of PliesID8	8
Number of PliesID9	8
Number of PliesID10	8
Number of PliesID11	8

Step #14

After all the inputs have been assigned to the Excel sheet 'Team (B)', please go to the Excel sheet within the same workbook labeled 'Input'. The file should look like the figure below.

UAV Composite Structural Analysis - MATLAB (UAV-CSA)

SE-143A Design of Composite Structures, University of California, San Diego (Copyright J.B. Kosmatka, 2020)

Version: Winter, 2020 (v4)

Project Title: UCSD Stern UAV Test Case

Variable	Description	Value	Units
Input	Input Units	1	1 = US, 2 = SI
Output	Output Units	1	1 = US, 2 = SI

X Project 1: Aircraft Performance - Calculation of Aircraft Performance, Weight, and V-n Diagram

1.a) Aircraft Aerodynamic Definition

Variable	Description	Value	Units
$dC_L/d\alpha$	Lift Curve Slope	0.113	1/degree
α_0	Zero Lift Angle	-2.2	degree
$C_{L,max}$ (+)	Max Lift at Stall (+)	1.4	1
α_{stall} (+)	Stall Angle (+)	10.2	degree
$C_{L,max}$ (-)	Max Lift at Stall (-)	-1.4	1
α_{stall} (-)	Stall Angle (-)	-14.6	degree
C_{m}	Wing Moment Coefficient	-0.085	1
$C_{D,f}$	Parasitic Drag - Fuselage	0.017	1
$C_{D,W}$	Parasitic Drag - Wing	0.011	1
C_{iW}	Induced Drag Coefficient	0.0226	1
d_0	Spanwise drag amplification	1	1
d_{1}	Spanwise drag amplification	0.2	1
Hp	Maximum Motor Power	5	Hp or Watts
η	Propeller Efficiency	85	%

Do not worry about the input in any of the cells except the ones talked about in the following steps, as the code does not read these cells for this 2 Cell Analysis.

Step #15

Scroll down to the cell 'E83', this is where you will define the beam length for this analysis. The units will correspond to inches as this analysis is done in the English system.

L	Wing-Structural Length	60	inch or m

Step #16

Scroll down to cell 'E:153', this is where the number of cross sections are accounted for. Enter the desired refinement in the cell given below.

Variable	Description	Value	Units
dx	discretize wing length	80	1

Step #17

Scroll down to cell 'E:188', this is where the number of subdivisions of each wing segment (corresponding to the node locations specified earlier) can be defined.

Variable	Description	Value	Units
ds	subdivide each wing skin segmer	10	1

Step #18

Finally, save and close the file 'SE143A UAV-CSA INPUT (v4).xlsx' and open up the MATLAB file labeled 'SE143A_WingAnalysisCode_vGJnCo.m'. The file pop-up screen should be similar to the one seen below.

```
% . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
% .
% .  SE-143B: Aerostructures Senior Capstone II
% .
% .  Title:   Bending Stress Analysis
% .  Author:  Team Airbenders
% .  Revised: 4/22/2020
% .
% .  Input  File: SE143A UAV-CSA INPUT (v4).xlsx
% .               2020 03 09 Wing Planform.xlsx
% .
% .  Output File: SE143A UAV-CSA OUTPUT(v1).xlsx [sheet: 5]
% . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
clear all; close all; clc;

% Define Input and Output EXCEL Files near the top of (M) file
inFile  = 'SE143A UAV-CSA INPUT (v4).xlsx';
inFilePlanform = '2020 03 09 Wing Planform.xlsx';

outFile = 'SE143A UAV CSA OUTPUT (v1).xlsx';

%%
% . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
% .  Section 1: Take input from Excel File
% . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
```

Simply, run the code using the 'Run' button in the 'Editor' section of the 'Toolstrip'.

Step #19

To view results, open up the Excel file 'SE143A UAV CSA OUTPUT (v1)'. The first few sheets will not be populated as those belong to the Wing Analysis portion of the code, but the following sheets will be populated with figures depicting the analysis conclusions: '3) Wing Definition', '4) Shear Moment Diagrams', '5) Wing Bending', '6) Wing Shear'.

3 Cell Composite Analysis

Step #1

In order to run the necessary 3 Cell Composite Wing Analysis test case the user will need to open the ‘SE143A UAV-CSA INPUT.xlsx’ file within the file directory of the submitted code. Please be in the Excel Sheet labeled ‘Input’. Once the file is opened, it should look like the file below.

UAV Composite Structural Analysis - MATLAB (UAV-CSA)

SE-143A Design of Composite Structures, University of California, San Diego (Copyright J.B. Kosmatka, 2020)

Version: Winter, 2020 (v4)

Project Title: UCSD Sterna UAV Test Case

Variable	Description	Value	Units
input	Input Units	1	1 = US, 2 = SI
Output	Output Units	1	1 = US, 2 = SI

X Project 1: Aircraft Performance - Calculation of Aircraft Performance, Weight, and V-n Diagram

1.a) Aircraft Aerodynamic Definition

Variable	Description	Value	Units
$dC_L/d\alpha$	Lift Curve Slope	0.113	1/degree
α_0	Zero Lift Angle	-2.2	degree
$C_{L max}$ (+)	Max Lift at Stall (+)	1.4	1
α_{stall} (+)	Stall Angle (+)	10.2	degree
$C_{L max}$ (-)	Max Lift at Stall (-)	-1.4	1
α_{stall} (-)	Stall Angle (-)	-14.6	degree
C_{m}	Wing Moment Coefficient	-0.095	1
$C_{D0,f}$	Parasitic Drag - Fuselage	0.017	1
$C_{D0,W}$	Parasitic Drag - Wing	0.011	1
C_{DiW}	Induced Drag Coefficient	0.0226	1
d_0	Spanwise drag amplification	1	1
d_1	Spanwise drag amplification	0.2	1
Hp	Maximum Motor Power	5	Hp or Watts
η	Propeller Efficiency	85	%

Step #2

Underneath the heading ‘Project 1: Aircraft Performance - Calculation of Aircraft Performance, Weight, and V-n Diagram’ proceed to fill in all the highlighted yellow cells with user input.

Step #3

Underneath the heading ‘Project 2: Aircraft Wing Definition and Loading - Calculate Wing and Tail Loading’ proceed to fill in all the highlighted yellow cells. However, there is no need to populate the region down below, as the 3 Cell Composite Analysis Code does not read from here.

(x/L)	Wing Station	Linear Chord	Actual Chord	Linear Sweep	(c/4) Sweep	Linear Twist	Twist
nondimen	inch					degree	
0	0	12		0.000		0	0
0.05	3.225	11.462		0.000		0.025	0
0.1	6.45	10.924		0.000		0.05	0
0.15	9.675	10.386		0.000		0.075	0
0.2	12.9	9.848		0.000		0.1	0
0.25	16.125	9.31		0.000		0.125	0
0.3	19.35	8.772		0.000		0.15	0
0.35	22.575	8.234		0.000		0.175	0
0.4	25.8	7.696		0.000		0.2	0
0.45	29.025	7.158		0.000		0.225	0
0.5	32.25	6.62		0.000		0.25	0
0.55	35.475	6.082		0.000		0.275	0.05
0.6	38.7	5.544		0.000		0.3	0.1
0.65	41.925	5.006		0.000		0.325	0.15
0.7	45.15	4.468		0.000		0.35	0.2
0.75	48.375	3.93		0.000		0.375	0.25
0.8	51.6	3.392		0.000		0.4	0.3
0.85	54.825	2.854		0.000		0.425	0.35
0.9	58.05	2.316		0.000		0.45	0.4
0.95	61.275	1.778		0.000		0.475	0.45
1	64.5	1.24		0.000		0.5	0.5

Step #4

Underneath the heading ‘Project 3: Aircraft Wing Structural Definition and Section Properties’ do not fill in any of the highlighted cells, as the 3 Cell Composite Analysis Code does not read from here.

Step #5

Underneath the heading ‘Project 4: Internal Shear and Moment Diagrams’ do not fill in any of the highlighted cells, as the 3 Cell Composite Analysis Code does not read from here.

Step #6

Underneath the heading ‘Project 6: Wing Shear Behavior - Calculate Stringer Stresses Only’’, fill cell ‘E:188’ so that the wing skin segments along the half-span can be discretized, as seen below. Note for the 3 Cell Composite Analysis, because there is a fixed number of 89 cross sections, increasing the subdivisions will cause the code to take a long time to run due to first ply failure analysis. For reference, a ds value of 2 will take about 10 minutes to run with FPF.

Variable	Description	Value	Units
ds	subdivide each wing skin segmer	10	1

Step #7

Underneath the heading ‘Project 8: Fuselage Analysis’ do not populate these cells, we do not read this data for our 3 Cell Composite Analysis for the wing.

Step #8

After populating the sheet ‘Input’, we can begin to populate the necessary cells within the same workbook, but now open the sheet labeled ‘Team (B)’. The file should look like the one below.

UAV Composite Structural Analysis - Team (B) Input

SE-143B Design of Composite Structures, University of California, San Diego (Copyright J.B. Kosmatka, 2020)

X	Project 1:	Additional Input										
Ply #	1	2	3	4	5	6	7	8	9	10	11	12
CompID1 (Material ID)	7	7	7									
CompID2 (Material ID)	7	7	7	4	4	4						
CompID3 (Material ID)	4	4										
CompID4 (Material ID)	7	7	7									
CompID5 (Material ID)	1	1	1	1	1	1	1	1				
CompID6 (Material ID)	1	1	1	1	1	1	1	1				
CompID7 (Material ID)	1	1	1	1	1	1	1	1				
CompID8 (Material ID)	1	1	1	1	1	1	1	1				
CompID9 (Material ID)	1	1	1	1	1	1	1	1				
CompID10 (Material ID)	1	1	1	1	1	1	1	1				
CompID11(Material ID)	1	1	1	1	1	1	1	1				
THICKNESSID1	0.0085	0.0085	0.0085									
THICKNESSID2	0.0085	0.0085	0.0085	0.012	0.012	0.012						
THICKNESSID3	0.012	0.012										
THICKNESSID4	0.0085	0.0085	0.0085									
THICKNESSID5	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID6	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID7	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID8	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID9	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID10	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001				
THICKNESSID11	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001		x		
RotationID1	45	45	45									
RotationID2	45	45	45	0	45	0						
RotationID3	45	45										
RotationID4	45	45	45									
RotationID5	0	0	0	0	0	0	0	0				
RotationID6	0	0	0	0	0	0	0	0				
RotationID7	0	0	0	0	0	0	0	0				
RotationID8	0	0	0	0	0	0	0	0				
RotationID9	0	0	0	0	0	0	0	0				
RotationID10	0	0	0	0	0	0	0	0				
RotationID11	0	0	0	0	0	0	0	0				
Number of PliesID1	3											
Number of PliesID2	6											
Number of PliesID3	2											
Number of PliesID4	3											
Number of PliesID5	8											
Number of PliesID6	8											
Number of PliesID7	8											
Number of PliesID8	8											

Step #9

The user should proceed to the section of the file corresponding to heading ‘Project 2: Validation Studies Input’. In order to ensure that 3 Cell Composite Analysis is being analyzed, be sure to input a value of 5 to the corresponding ‘Test Case Input Flag’ as shown here.

X	Project 2:
Test Case Input Flag	5
1 Cell Isotropic	1
1 Cell Composite	2
2 Cell Isotropic	3
2 Cell Composite	4
3 Cell Wing	5

Step #10

After providing the above input, proceed to the section ‘Project 3: Large Wing Design Studies Input’, it should look like the image seen here. In this section, make sure the white cells in the region seen here are populated with 11.0 values.

Test Case 3	er ID (from Database)	
Station (x/c) - PREFERRED	y (upper)	y (lower)
0.000		
0.010	11.000	11.000
0.025		
0.050		
0.100		
0.150	11.000	11.000
0.250	11.000	11.000
0.350	11.000	11.000
0.500		
0.650	11.000	11.000
0.800	11.000	11.000
1.000		

This corresponds to how the bending and shear flow analysis is conducted and is necessary for the code to run.

Step #11

To the right of the previous table, here is where the user can define the geometry needed for 3 Cell Analysis, the blacked out cells should not have any input.

Test Cases (3 Cell) - will read from wing planform excel file instead, no input required						
Node Location	x (inches)	y (inches)		Node Location	x (inches)	y (inches)
1				7		
2				8		
3				9		
4				10		
5				11		
6				12		

Note, all the cells are blacked out, this is because the nodes on the airfoil are placed in their respective position relative to the chord, by the figure in ‘Step #10’ highlighted yellow cells. These are the x/c positions of the nodes for a user defined NACA 4 series airfoil that was defined in ‘Step: #3’. Using this airfoil data and the Excel file ‘2020 03 09 Wing Planform.xlsx’ that yields the planform geometry and corresponding sweep, the total wing geometry is given. In our Full Wing Analysis, we used the NACA 4314 airfoil with this wing planform data to construct the wing that was to be analyzed (for a fixed amount of 89 cross sections which was given in the planform Excel file).

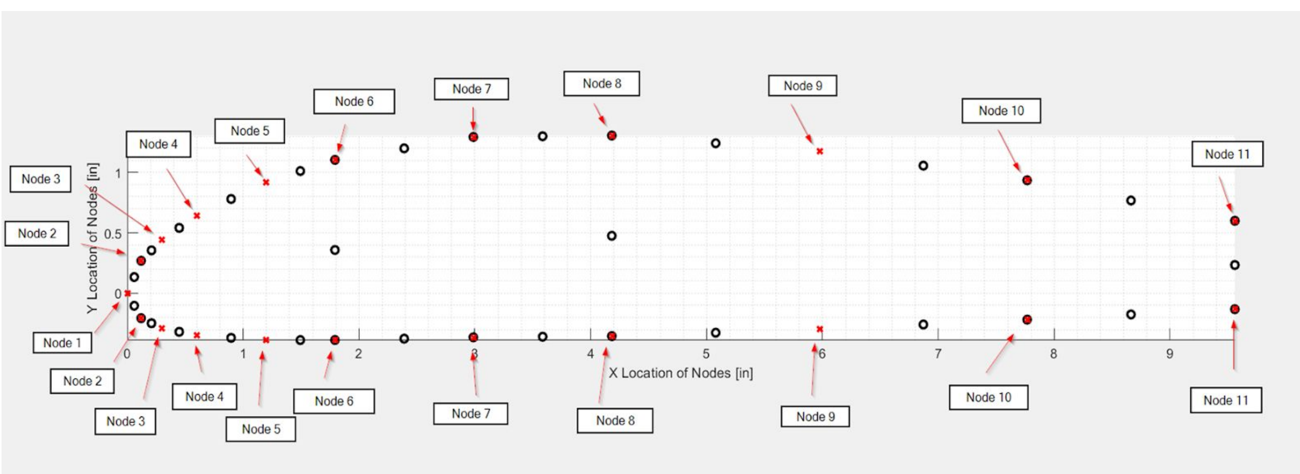
Step #12

Below the user defined node locations, is a table where the user can define the material properties required for analysis, as seen here.

Test Case (3 Cell)	in ID (from Database)	
Skin Connectivity	y (upper)	y (lower)
node 1 to node 2	10	10
node 2 to node 3	8	1
node 3 to node 4	8	1
node 4 to node 5	8	1
node 5 to node 6	8	1
node 6 to node 7	2	2
node 7 to node 8	2	2
node 8 to node 9	2	2
node 9 to node 10	7	3
node 10 to node 1	6	4
node 11 to node 1	[redacted]	

Spar	ID
Fwd Vertical Box	5
Vertical Shear W	[redacted]
Bck Vertical Box \	5
Struct Box Wall (nc	9

Because this is a composite laminate analysis, various material ID's will be input here. Also, for the spar ID's only the 'Fwd Vertical Box', 'Bck Vertical Box', 'Struct Box Wall' ID's are used, but all 4 cells need input to run the code. Below is a reference to the node locations that correspond to any cross section on the 3 Cell Full Wing Analysis..



Step #13

After assigning the material ID, scroll back up to the section ‘Project 1: Additional Input’. This is where the user can define the unique laminate layups that will be used in their structure.

Step #14

Looking at the first region, as seen below

X	Project 1: Additional Input		
Ply #	1	2	3
CompID1 (Material ID)	7	7	7
CompID2 (Material ID)	7	7	7
CompID3 (Material ID)	4	4	
CompID4 (Material ID)	7	7	7
CompID5 (Material ID)	1	1	1
CompID6 (Material ID)	1	1	1
CompID7 (Material ID)	1	1	1
CompID8 (Material ID)	1	1	1
CompID9 (Material ID)	1	1	1
CompID10 (Material ID)	1	1	1
CompID11(Material ID)	1	1	1

This is where laminates are defined to a corresponding material ID. This corresponding material ID pertains to an ID in another Excel file. Please open the Excel file ‘SE142_Material_DataBaseHK.xlsx’.

Step #15

The file should resemble the figure below.

Aerospace and Composite Material Data Base, Compiled by John Kosmatka
Updated: 11/10/2018

Reinforcement (Fiber) Properties Data Base

Variable	Description	Units	Carbon						
	Material ID Number		1	2	3	4	5	6	7
	Material Name:		AS4	T300	T800	IM6	IM7	High Modulus	Ultra Modulus
	Fiber Diameter	inch	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
E_L	Young's Modulus (Longitudinal)	lb/in^2	33000000	33500000	34011300	36330000	40030000	53000000	70000000
E_T	Young's Modulus (Transverse)	lb/in^2	2400000	2175000	2047900	2020000	2755700	1300000	1100000
G_{LT}	Shear Modulus (L-T plane)	lb/in^2	3600000	4000000	2132000	7390000	3916000	2700000	2700000
G_{TT}	Shear Modulus (T-T plane)	lb/in^2	1000000	1015000	930850	1200000	1015000	700000	700000
ν_{LT}	Poisson ratio (L-T plane)		0.2	0.2	0.2462	0.26	0.2	0.2	0.2
ν_{TT}	Poisson ratio (T-T plane)		0.2	0.2	0.1	0.33	0.2	0.25	0.25
ρ_f	Weight Density	lb/in^3	0.05	0.06358	0.06503	0.063	0.0643	0.068	0.072
α_{fL}	Thermal expansion coefficient (Longitidinal)	(in/in)/°F	-0.0000003	-0.0000004	-0.0000004	-0.000000566	-0.0000001	-0.00000055	-0.00000055
α_{fT}	Thermal expansion coefficient (Tranverse)	(in/in)/°F	0.0000083	0.0000067	0.0000067	0.0000018	0.0000056	0.0000056	0.0000056
K_{fL}	Heat Conduction (Longitudinal)	BTU/hr/ft^2/°F/in	580	580	580	580	600	600	600
K_{fT}	Heat Conduction (Transverse)	BTU/hr/ft^2/°F/in	58	58	58	58	60	60	60
F_{fT}	Tension strength	lb/in^2	570000	362590	362390	415000	751295	190000	150000
F_{fC}	Compression strength	lb/in^2	-400000	-290000	-290000	-367000	-464120	-170000	-150000
ε_{fT}	Tension Strain - Ultimate	in/in	0.0173	0.0109	0.0107	0.0115	0.0188	0.0036	0.0022
ε_{fC}	Compression Strain - Ultimate	in/in	-0.0122	-0.0087	-0.0086	-0.0102	-0.0116	-0.0033	-0.0022
	Reference								

Please scroll down to the section labeled ‘Orthotropic Lamina Properties-Unidirectional and Fabrics’.

Orthotropic Lamina Properties - Unidirectional and Fabrics

	Variable	Description	Units	Carbon/epoxy			
1		Material ID Number		1	2	3	4
2		Material Name:		uni (AS-4/3501-6)	uni (IM6/3501-6)	uni (IM7/977-3)	Woven (AGP370-5H/35
3	V_f	Fiber Volume Fraction		0.63	0.635	0.65	0.62
4	E_1	Young's Modulus (Longitudinal)	lb/in^2	21300000	23300000	27700000	11200000
5	E_2	Young's Modulus (Transverse)	lb/in^2	1500000	1395000	1440000	10900000
6	E_3	Young's Modulus (Out-of-Plane)	lb/in^2	1500000	1395000	1440000	2000000
7	G_{12}	Shear Modulus (1-2 plane)	lb/in^2	1000000	916000	1130000	940000
8	G_{13}	Shear Modulus (1-3 plane)	lb/in^2	1000000	916000	1130000	740000
9	G_{23}	Shear Modulus (2-3 plane)	lb/in^2	540000	520000	600000	590000
10	v_{12}	Poisson Ratio (1-2 plane)		0.27	0.2965	0.35	0.06
11	v_{13}	Poisson Ratio (1-3 plane)		0.27	0.2965	0.35	0.37
12	v_{23}	Poisson Ratio (2-3 plane)		0.45	0.468	0.45	0.45

As can be seen there are material ID’s underneath the heading ‘Carbon/epoxy’ to help designate which material corresponds to which ID’s. The previously mentioned Excel file uses these ID’s to designate what the material properties are for each lamina in a specific layup. Now we can go back to the ‘SE143A UAV-CSA INPUT.xlsx’ file to continue interpreting the inputs.

Step #16

Looking at the region below were we previously defined the layup materials that pertained to each lamina, we can see another region corresponding to thicknesses of each lamina of each layup, as seen here.

THICKNESSID1	0.0085	0.0085	0.0085
THICKNESSID2	0.0085	0.0085	0.0085
THICKNESSID3	0.012	0.012	
THICKNESSID4	0.0085	0.0085	0.0085
THICKNESSID5	0.001	0.001	0.001
THICKNESSID6	0.001	0.001	0.001
THICKNESSID7	0.001	0.001	0.001
THICKNESSID8	0.001	0.001	0.001
THICKNESSID9	0.001	0.001	0.001
THICKNESSID10	0.001	0.001	0.001
THICKNESSID11	0.001	0.001	0.001

Here the user can define what thickness each lamina for every layup will be.

Step #18

After defining the thickness of each lamina for each individual laminate, we can define the appropriate lamina orientation as well as seen down below.

RotationID1	45	45	45
RotationID2	45	45	45
RotationID3	45	45	
RotationID4	45	45	45
RotationID5	0	0	0
RotationID6	0	0	0
RotationID7	0	0	0
RotationID8	0	0	0
RotationID9	0	0	0
RotationID10	0	0	0
RotationID11	0	0	0

Step #19

Also, the laminate section of the ‘SE 143A UAV-CSA INPUT.xlsx’ requires the number of plies for each laminate definition to be defined as seen in the region here.

Number of PliesID1	3
Number of PliesID2	6
Number of PliesID3	2
Number of PliesID4	3
Number of PliesID5	8
Number of PliesID6	8
Number of PliesID7	8
Number of PliesID8	8
Number of PliesID9	8
Number of PliesID10	8
Number of PliesID11	8

Step #20

Lastly, it is **required** that every row of the laminate definition table is populated with values. All the columns do not have to be populated, as this corresponds to the amount of plies in each laminate definition. This can be seen in an example given here.

X	Project 1:
Ply #	1
CompID1 (Material ID)	7
CompID2 (Material ID)	7
CompID3 (Material ID)	4
CompID4 (Material ID)	7
CompID5 (Material ID)	1
CompID6 (Material ID)	1
CompID7 (Material ID)	1
CompID8 (Material ID)	1
CompID9 (Material ID)	1
CompID10 (Material ID)	1
CompID11(Material ID)	1
THICKNESSID1	0.0085
THICKNESSID2	0.0085
THICKNESSID3	0.012
THICKNESSID4	0.0085
THICKNESSID5	0.001
THICKNESSID6	0.001
THICKNESSID7	0.001
THICKNESSID8	0.001
THICKNESSID9	0.001
THICKNESSID10	0.001
THICKNESSID11	0.001
RotationID1	45
RotationID2	45
RotationID3	45
RotationID4	45
RotationID5	0
RotationID6	0
RotationID7	0
RotationID8	0
RotationID9	0
RotationID10	0
RotationID11	0
Number of PliesID1	3
Number of PliesID2	6
Number of PliesID3	2
Number of PliesID4	3
Number of PliesID5	8
Number of PliesID6	8
Number of PliesID7	8
Number of PliesID8	8
Number of PliesID9	8
Number of PliesID10	8
Number of PliesID11	8

Step #21

Finally, save and close the file ‘SE143A UAV-CSA INPUT (v4).xlsx’ and open up the MATLAB file labeled ‘SE143A_WingAnalysisCode_vGJnCo.m’. The file pop-up screen should be similar to the one seen below.

```
% . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
% .
% .  SE-143B: Aerostructures Senior Capstone II
% .
% .  Title:   Bending Stress Analysis
% .  Author:  Team Airbenders
% .  Revised: 4/22/2020
% .
% .  Input  File: SE143A UAV-CSA INPUT (v4).xlsx
% .               2020 03 09 Wing Planform.xlsx
% .
% .  Output File: SE143A UAV-CSA OUTPUT(v1).xlsx [sheet: 5]
% . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
clear all; close all; clc;

% Define Input and Output EXCEL Files near the top of (M) file
inFile  = 'SE143A UAV-CSA INPUT (v4).xlsx';
inFilePlanform = '2020 03 09 Wing Planform.xlsx';

outFile = 'SE143A UAV CSA OUTPUT (v1).xlsx';


%%
% . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
% .  Section 1: Take input from Excel File
% . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
```

Simply, run the code using the ‘Run’ button in the ‘Editor’ section of the ‘Toolstrip’.

Step #13

To view results, open up the Excel file ‘SE143A UAV CSA OUTPUT (v1)’. All sheets besides the ‘0) Echo’ and ‘7) Wing Vibrations’ should be populated.