TERM PROJECT
MECH-530
Progress Report 2

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Overview: This progress report features the output of a Python script in IPython Notebook. The input interface has been modified to output the off-axis Q and S matrices as well as stress/strain quantities. The output is organized in two parts corresponding to the layups given in the Assignment 2 instructions.

In [1]:
```
run MECH530_main.py
```

```
----------------------------------QUESTION 1----------------------------------
The laminate is given by the following plybook where the highest ply number '8'
 indicates the top layer, while the first ply number '1' indicates the bottom l
ayer.

Unique Ply #, Fiber/Matrix, Orientation, Thickness
                             (degrees)      (mm)
     8         Kev49/Epoxy        45         0.125
     7         Kev49/Epoxy         0         0.125
     6         Kev49/Epoxy       -45         0.125
     5         Kev49/Epoxy        90         0.125
     4         Kev49/Epoxy        90         0.125
     3         Kev49/Epoxy       -45         0.125
     2         Kev49/Epoxy         0         0.125
     1         Kev49/Epoxy        45         0.125

PLIES AND THICKNESSES
-Total number of plies in the laminate: 8
-Total thickness of laminate is: 1.000 mm
-There is no core in the laminate (Zc = 0 mm)
-Laminate contains 1 Fiber/Matrix combination. The material properties for this
 combination shall be listed below.

RESIN/MATRIX 1 of 1: For Kev49/Epoxy, the given material properties are:

-Stiffness and Strength:

Ex =  76.0000 GPa, Ey =   5.5000 GPa, Es =   2.3000 GPa and nu_x =   0.3400

Xt = 1400.0000 MPa, Xc = 235.0000 MPa, Yt =  12.0000f MPa, Yc =  53.0000 MPa an
d Sc =  34.0000 MPa.


-The 'on-axis' matrices are given by the following:

 S_on =
[[   0.0132   -0.0045    0.0000]
 [  -0.0045    0.1818    0.0000]
 [   0.0000    0.0000    0.4348]] [1/GPa]

 Q_on =
[[  76.6412    1.8858    0.0000]
 [   1.8858    5.5464    0.0000]
 [   0.0000    0.0000    2.3000]] [GPa]

Now the off-axis [S] and [Q] matrices will be printed for each of the first 4 l
ayers in the layup (from the top) along with their respective [U] values.

PLY: 8
ORIENTATION: 45 degrees
Us_1 =    0.1263 [1/GPa]
Us_2 =   -0.0843 [1/GPa]
```

```
Us_3 =   -0.0289 [1/GPa]
Us_4 =   -0.0333 [1/GPa]
Us_5 =    0.3194 [1/GPa]

S_off =
[[   0.1552   -0.0622   -0.0843]
 [  -0.0622    0.1552   -0.0843]
 [  -0.0843   -0.0843    0.2039]] [1/GPa]

Uq_1 =   32.4418 GPa
Uq_2 =   35.5474 GPa
Uq_3 =    8.6520 GPa
Uq_4 =   10.5378 GPa
Uq_5 =   10.9520 GPa

Q_off =
[[  23.7898   19.1898   17.7737]
 [  19.1898   23.7898   17.7737]
 [  17.7737   17.7737   19.6040]] [GPa]

PLY: 7
ORIENTATION: 0 degrees
Us_1 =    0.1263 [1/GPa]
Us_2 =   -0.0843 [1/GPa]
Us_3 =   -0.0289 [1/GPa]
Us_4 =   -0.0333 [1/GPa]
Us_5 =    0.3194 [1/GPa]

S_off =
[[   0.0132   -0.0045   -0.0000]
 [  -0.0045    0.1818    0.0000]
 [  -0.0000    0.0000    0.4348]] [1/GPa]

Uq_1 =   32.4418 GPa
Uq_2 =   35.5474 GPa
Uq_3 =    8.6520 GPa
Uq_4 =   10.5378 GPa
Uq_5 =   10.9520 GPa

Q_off =
[[  76.6412    1.8858    0.0000]
 [   1.8858    5.5464    0.0000]
 [   0.0000    0.0000    2.3000]] [GPa]

PLY: 6
ORIENTATION: -45 degrees
Us_1 =    0.1263 [1/GPa]
Us_2 =   -0.0843 [1/GPa]
Us_3 =   -0.0289 [1/GPa]
Us_4 =   -0.0333 [1/GPa]
Us_5 =    0.3194 [1/GPa]

S_off =
[[   0.1552   -0.0622    0.0843]
 [  -0.0622    0.1552    0.0843]
 [   0.0843    0.0843    0.2039]] [1/GPa]
```

```
Uq_1 =   32.4418 GPa
Uq_2 =   35.5474 GPa
Uq_3 =    8.6520 GPa
Uq_4 =   10.5378 GPa
Uq_5 =   10.9520 GPa

Q_off =
[[  23.7898   19.1898  -17.7737]
 [  19.1898   23.7898  -17.7737]
 [ -17.7737  -17.7737   19.6040]] [GPa]

PLY: 5
ORIENTATION: 90 degrees
Us_1 =    0.1263 [1/GPa]
Us_2 =   -0.0843 [1/GPa]
Us_3 =   -0.0289 [1/GPa]
Us_4 =   -0.0333 [1/GPa]
Us_5 =    0.3194 [1/GPa]

S_off =
[[   0.1818   -0.0045    0.0000]
 [  -0.0045    0.0132   -0.0000]
 [   0.0000   -0.0000    0.4348]] [1/GPa]

Uq_1 =   32.4418 GPa
Uq_2 =   35.5474 GPa
Uq_3 =    8.6520 GPa
Uq_4 =   10.5378 GPa
Uq_5 =   10.9520 GPa

Q_off =
[[   5.5464    1.8858    0.0000]
 [   1.8858   76.6412    0.0000]
 [   0.0000    0.0000    2.3000]] [GPa]
```

In [1]:
```
run MECH530_main.py
```

```
----------------------------------QUESTION 2----------------------------------
The laminate is given by the following plybook where the highest ply number '1'
 indicates the top layer, while the first ply number '1' indicates the bottom l
ayer.

Unique Ply #, Fiber/Matrix, Orientation, Thickness
                              (degrees)      (mm)
     1        Kev49/Epoxy        30          0.125

PLIES AND THICKNESSES
-Total number of plies in the laminate: 1
-Total thickness of laminate is: 0.125 mm
-There is no core in the laminate (Zc = 0 mm)
-Laminate contains 1 Fiber/Matrix combination. The material properties for this
 combination shall be listed below.

RESIN/MATRIX 1 of 1: For Kev49/Epoxy, the given material properties are:
```

```
-Stiffness and Strength:

Ex =  76.0000 GPa, Ey =   5.5000 GPa, Es =   2.3000 GPa and nu_x =   0.3400

Xt = 1400.0000 MPa, Xc = 235.0000 MPa, Yt =  12.0000f MPa, Yc =  53.0000 MPa an
d Sc =  34.0000 MPa.


-The 'on-axis' matrices are given by the following:

 S_on =
[[   0.0132   -0.0045    0.0000]
 [  -0.0045    0.1818    0.0000]
 [   0.0000    0.0000    0.4348]] [1/GPa]

 Q_on =
[[  76.6412    1.8858    0.0000]
 [   1.8858    5.5464    0.0000]
 [   0.0000    0.0000    2.3000]] [GPa]

PLY: 1
ORIENTATION: 30 degrees
Us_1 =    0.1263 [1/GPa]
Us_2 =   -0.0843 [1/GPa]
Us_3 =   -0.0289 [1/GPa]
Us_4 =   -0.0333 [1/GPa]
Us_5 =    0.3194 [1/GPa]

S_off =
[[   0.0986   -0.0478   -0.1230]
 [  -0.0478    0.1829   -0.0230]
 [  -0.1230   -0.0230    0.2616]] [1/GPa]

Uq_1 =   32.4418 GPa
Uq_2 =   35.5474 GPa
Uq_3 =    8.6520 GPa
Uq_4 =   10.5378 GPa
Uq_5 =   10.9520 GPa

Q_off =
[[  45.8895   14.8638   22.8853]
 [  14.8638   10.3421    7.8996]
 [  22.8853    7.8996   15.2780]] [GPa]

COMPUTE OFF-AXIS STRAIN, ON-AXIS STRESS AND STRAIN FROM OFF-AXIS STRESS GIVEN:

Transpose of Off-axis stress =
[[   0.4200   -0.1650   -0.1350]] [GPa]

Transpose of Off-axis strain =
[[   0.0659   -0.0471   -0.0832]] [unitless]

Transpose of On-axis stress =
[[   0.1568    0.0982   -0.3208]] [GPa]
```

```
Transpose of On-axis strain =
[[   0.0016    0.0171   -0.1395]] [unitless]
```