



McGILL UNIVERSITY

MECHANICS OF COMPOSITE MATERIALS

MECH 530

Assignment 2

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Question 1

Orientation list :

Orientation [degrees] :
[45, 0, -45, 90, 90, -45, 0, 45]

Number of plies :

8

Material properties :

```
'      ID :          4  [-]'  
'fiber/matrix :      Kev49/Epoxy  [-]'  
'      name :      Kevlar/Epoxy  [-]'  
'      ex :          76.0000  [GPA]'  
'      ey :          5.5000  [GPA]'  
'      es :          2.3000  [GPA]'  
'      nux :          0.3400  [-]'  
'      xt :        1400.0000  [MPa]'  
'      xc :        235.0000  [MPa]'  
'      yt :        12.0000  [MPa]'  
'      yc :        53.0000  [MPa]'  
'      sc :        34.0000  [MPa]'  
'      h0 :          0.1250  [mm]'  
'      nuy :          0.0246  [-]'
```

Modulus and Compliance on-axis matrices :

Layer number : 1
Orientation : 45 [degrees]

S_on [1/GPa] :

```
[[ 0.0132 -0.0045 0.0000]  
 [ -0.0045 0.1818 0.0000]  
 [ 0.0000 0.0000 0.4348]]
```

Q_on [GPa] :

```
[[ 76.6412 1.8858 0.0000]  
 [ 1.8858 5.5464 0.0000]  
 [ 0.0000 0.0000 2.3000]]
```

Modulus and Compliance off-axis matrices.

Layer number : 1
Orientation : 45 [degrees]

U's for S [1/GPa]

```
U1 : 0.1263  
U2 : -0.0843  
U3 : -0.0289  
U4 : -0.0333  
U5 : 0.3194
```

S_off [1/GPa] :

```
[[ 0.1552 -0.0622 -0.0843]  
 [ -0.0622 0.1552 -0.0843]  
 [ -0.0843 -0.0843 0.2039]]
```

U's for Q [GPa]

```
U1 : 32.4418  
U2 : 35.5474  
U3 : 8.6520  
U4 : 10.5378  
U5 : 10.9520
```

Q_off [GPa] :

```
[[ 23.7898 19.1898 17.7737]
```

```
[ 19.1898  23.7898  17.7737]
[ 17.7737  17.7737  19.6040]]
```

Layer number : 2
Orientation : 0 [degrees]

U's for S [1/GPa]
U1 : 0.1263
U2 : -0.0843
U3 : -0.0289
U4 : -0.0333
U5 : 0.3194
S_off [1/GPa] :
[[0.0132 -0.0045 0.0000]
[-0.0045 0.1818 0.0000]
[0.0000 0.0000 0.4348]]

U's for Q [GPa]
U1 : 32.4418
U2 : 35.5474
U3 : 8.6520
U4 : 10.5378
U5 : 10.9520
Q_off [GPa] :
[[76.6412 1.8858 0.0000]
[1.8858 5.5464 0.0000]
[0.0000 0.0000 2.3000]]

Layer number : 3
Orientation : -45 [degrees]

U's for S [1/GPa]
U1 : 0.1263
U2 : -0.0843
U3 : -0.0289
U4 : -0.0333
U5 : 0.3194
S_off [1/GPa] :
[[0.1552 -0.0622 0.0843]
[-0.0622 0.1552 0.0843]
[0.0843 0.0843 0.2039]]

U's for Q [GPa]
U1 : 32.4418
U2 : 35.5474
U3 : 8.6520
U4 : 10.5378
U5 : 10.9520
Q_off [GPa] :
[[23.7898 19.1898 -17.7737]
[19.1898 23.7898 -17.7737]
[-17.7737 -17.7737 19.6040]]

Layer number : 4
Orientation : 90 [degrees]

U's for S [1/GPa]
U1 : 0.1263
U2 : -0.0843
U3 : -0.0289
U4 : -0.0333
U5 : 0.3194
S_off [1/GPa] :
[[0.1818 -0.0045 0.0000]
[-0.0045 0.0132 -0.0000]
[0.0000 -0.0000 0.4348]]

U's for Q [GPa]
U1 : 32.4418
U2 : 35.5474
U3 : 8.6520
U4 : 10.5378
U5 : 10.9520
Q_off [GPa] :
[[5.5464 1.8858 0.0000]
[1.8858 76.6412 0.0000]
[0.0000 0.0000 2.3000]]

Question 2

Orientation :

Orientation [degrees] :
[30]

Number of plies :

Total number of plies:
1

Material properties :

```
'      ID :          4  [-]'  
'fiber/matrix :      Kev49/Epoxy  [-]'  
'      name :      Kevlar/Epoxy  [-]'  
'      ex :          76.0000  [GPA]'  
'      ey :          5.5000  [GPA]'  
'      es :          2.3000  [GPA]'  
'      nux :          0.3400  [-]'  
'      xt :        1400.0000  [MPa]'  
'      xc :        235.0000  [MPa]'  
'      yt :         12.0000  [MPa]'  
'      yc :         53.0000  [MPa]'  
'      sc :         34.0000  [MPa]'  
'      h0 :          0.1250  [mm]'  
'      nuy :          0.0246  [-]'
```

Modulus and Compliance on-axis matrices :

Layer number : 1
Orientation : 30 [degrees]

S_on [1/GPa] :

```
[[  0.0132  -0.0045   0.0000]  
 [ -0.0045   0.1818   0.0000]  
 [  0.0000   0.0000   0.4348]]
```

Q_on [GPa] :

```
[[ 76.6412   1.8858   0.0000]  
 [  1.8858  5.5464   0.0000]  
 [  0.0000   0.0000  2.3000]]
```

Modulus and Compliance off-axis matrices :

Layer number : 1
Orientation : 30 [degrees]

U's for S [1/GPa]

```
U1 :  0.1263  
U2 : -0.0843  
U3 : -0.0289  
U4 : -0.0333  
U5 :  0.3194  
S_off [1/GPa] :  
[[  0.0986  -0.0478  -0.1230]  
 [ -0.0478   0.1829  -0.0230]  
 [ -0.1230  -0.0230   0.2616]]
```

U's for Q [GPa]

```
U1 : 32.4418  
U2 : 35.5474  
U3 :  8.6520  
U4 : 10.5378
```

```
U5 : 10.9520
Q_off [GPa] :
[[ 45.8895  14.8638  22.8853]
 [ 14.8638  10.3421  7.8996]
 [ 22.8853  7.8996  15.2780]]
```

Load [GPa] :

```
[[ 0.4200]
 [ -0.1650]
 [ 0.1350]]
```

Two different ways of obtaining off-axis strain

1. Use off-axis compliance matrix
2. Transform stress, use on-axis compliance matrix and transform strain.

Method 1

On-axis stress [GPa] using stress transformation :

```
[[ 0.3907]
 [ -0.1357]
 [ -0.1858]]
```

On-axis strain [-] using on-axis compliance matrix:

```
[[ 0.0057]
 [ -0.0264]
 [ -0.0808]]
```

Off-axis strain [-] using strain transformation :

```
[[ 0.0327]
 [ -0.0534]
 [ -0.0125]]
```

Method 2

Off-axis strain [-] using off-axis compliance matrix

```
[[ 0.0327]
 [ -0.0534]
 [ -0.0125]]
```