
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 :**

```
[[   0.1568]
 [   0.0982]
 [  -0.3208]]
```

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

```
[[   0.0016]
 [   0.0171]
 [  -0.1395]]
```

**Off-axis strain [-] using strain transformation :**

```
[[   0.0659]
 [  -0.0471]
 [  -0.0832]]
```

# Method 2

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

```
[[   0.0659]
 [  -0.0471]
 [  -0.0832]]
```