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

```
PLYBOOK (READ FROM EXCEL FILE AND SUMMARIZED HERE)

The laminate is given by the following plybook where the highest ply number '17
' indicates the top layer, while the first ply number '1' indicates the bottom
layer.

Unique Ply #, Fiber/Matrix, Orientation, Thickness
                              (degrees)      (mm)
    17         T300/N5208         0         0.125
    16         T300/N5208        10         0.125
    15         T300/N5208        17         0.125
    14         T300/N5208       -17         0.125
    13         T300/N5208        37         0.125
    12         T300/N5208       -37         0.125
    11         T300/N5208        35         0.125
    10         T300/N5208        13         0.125
     9               CORE         0         1.500
     8         T300/N5208        13         0.125
     7         T300/N5208        35         0.125
     6         T300/N5208       -37         0.125
     5         T300/N5208        37         0.125
     4         T300/N5208       -17         0.125
     3         T300/N5208        17         0.125
     2         T300/N5208        10         0.125
     1         T300/N5208         0         0.125

PLIES AND THICKNESSES
-Total number of plies in the laminate: 17
-Total thickness of laminate is: 3.500 mm
-The core thickness is 2 Zc = 1.500 mm
-Note that the CORE will be ommitted in the following stress and safety factor
tables
-Laminate contains 1 Fiber/Matrix combination. The material properties for this
 combination shall be listed below.

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MATERIALS AND MATERIAL PROPERTIES

RESIN/MATRIX 1 of 1: For T300/N5208, the given material properties are:

-Stiffness and Strength:

Ex = 181.0000 GPa, Ey =  10.3000 GPa, Es =   7.1700 GPa and nu_x =   0.2800

Xt = 1500.0000 MPa, Xc = 1500.0000 MPa, Yt =  40.0000 MPa, Yc = 246.0000 MPa an
d Sc =  68.0000 MPa.

-The 'on-axis' matrices are given by the following:
S_on =
[[      0.0   -0.0015       0.0]
 [  -0.0015    0.0971       0.0]
 [      0.0       0.0    0.1395]] [1/GPa]
```

```
Q_on =
[[ 181.8111    2.8969       0.0]
 [   2.8969   10.3462       0.0]
 [      0.0       0.0    7.1700]] [GPa]

-The linear combinations of the modulus, independent of ply angle are the follo
wing:
Us_1 =    0.0535 [1/GPa]
Us_2 =   -0.0485 [1/GPa]
Us_3 =   -0.0049 [1/GPa]
Us_4 =   -0.0065 [1/GPa]
Us_5 =    0.1198 [1/GPa]

-The linear combinations of the modulus, dependent on ply angle are the followi
ng:
Uq_1 =   76.3682 GPa
Uq_2 =   85.7325 GPa
Uq_3 =   19.7104 GPa
Uq_4 =   22.6074 GPa
Uq_5 =   26.8804 GPa

-The 'Stiffness' [A] and 'Compliance' [a] matrices are given by the following:
A =
[[   0.2716    0.0419    0.0287]
 [   0.0419    0.0405    0.0082]
 [   0.0287    0.0082    0.0505]] [GN/m]

a =
[[   4.5484   -4.3257   -1.8781]
 [  -4.3257   29.6417   -2.3697]
 [  -1.8781   -2.3697   21.2676]] [m/GN]

-The 'In-Plane Flexural Modulus' [D] and 'In-Plane Flexural Compliance' [d] mat
rices are given by the following:
D =
[[   0.4815    0.0561    0.0413]
 [   0.0561    0.0579    0.0105]
 [   0.0413    0.0105    0.0702]] [kNm]

d =
[[2421.4674 -2147.7291 -1103.8042]
 [-2147.7291 19670.0897 -1675.4605]
 [-1103.8042 -1675.4605 15152.8785]] [1/MNm]

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OFF-AXIS APPLIED RESULTANTS: CASE 1

Curvature K =
[[  -2.0963    0.3483   -0.2439]] [1/m]

(INPUT) Off-axis Applied stress resultant N =
[[-22400.0000 -3000.0000 -2000.0000]] [N/m]

(INPUT) Off-axis Applied moment resultant M =
[[-1000.0000 -100.0000 -100.0000]] [N]
```

FAILURE CRITERION AND ANALYSIS

MAXIMUM STRESS:
-Minimum R = 2.204 and laminate fails in Fiber Compression at TOP of ply 17
-The load vectors which cause the failure are:
R*N =
[[-49.3637   -6.6112   -4.4075]] [kN/m]
R*M =
[[-2.2037   -0.2204   -0.2204]] [kN]

QUADRATIC POLYNOMIAL:
-Minimum R = 2.162 and laminate fails at BOT of ply 1
-The load vectors which cause the failure are:
R*N =
[[-48.4338   -6.4867   -4.3244]] [kN/m]
R*M =
[[-2.1622   -0.2162   -0.2162]] [kN]

HASHIN CRITERION:
-Minimum R = 2.204 and laminate fails in Fiber Compression at TOP of ply 17
-The load vectors which cause the failure are:
R*N =
[[-49.3637   -6.6112   -4.4075]] [kN/m]
R*M =
[[-2.2037   -0.2204   -0.2204]] [kN]

OFF-AXIS APPLIED RESULTANTS: CASE 2

Curvature K =
[[-2.0411   0.3614   -0.4209]] [1/m]

(INPUT) Off-axis Applied stress resultant N =
[[-20800.0000 -280.0000 -2200.0000]] [N/m]

(INPUT) Off-axis Applied moment resultant M =
[[-980.0000 -98.0000 -110.0000]] [N]

FAILURE CRITERION AND ANALYSIS

MAXIMUM STRESS:
-Minimum R = 2.260 and laminate fails in Fiber Compression at TOP of ply 17
-The load vectors which cause the failure are:
R*N =
[[-47.0181   -0.6329   -4.9731]] [kN/m]
R*M =
[[-2.2153   -0.2215   -0.2487]] [kN]

QUADRATIC POLYNOMIAL:
-Minimum R = 2.188 and laminate fails at BOT of ply 1
-The load vectors which cause the failure are:
R*N =
[[-45.5095   -0.6126   -4.8135]] [kN/m]
R*M =
[[-2.1442   -0.2144   -0.2407]] [kN]

```
HASHIN CRITERION:
-Minimum R = 2.260 and laminate fails in Fiber Compression at TOP of ply 17
-The load vectors which cause the failure are:
R*N =
[[ -47.0181   -0.6329   -4.9731]] [kN/m]
R*M =
[[  -2.2153   -0.2215   -0.2487]] [kN]

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In [11]:
```
#stress_df1
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In [12]:
```
#failure_df1
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In [13]:
```
#stress_df2
```

In [14]:
```
#failure_df2
```

In [15]:
```
#print stress_df1.to_latex()
```

In [16]:
```
#print failure_df1.to_latex(float_format=lambda x:"%.3f" % x)
```

In [17]:
```
#print stress_df2.to_latex()
```

In [18]:
```
#print failure_df2.to_latex(float_format=lambda x:"%.3f" % x)
```