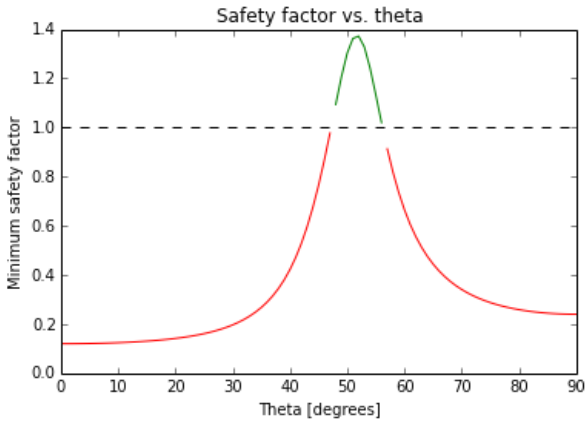
Design #1




```
Maximum R (1.37) occurs for theta = 52 degrees
```

Complete output

** Ply orientation list **

```
Orientation [degrees] :
[52, -52, -52, 52]
```

Number of plies

```
4
```

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]'
'         rho :       1.4600  [g/cm3]'
'         nuy :       0.0246  [-]'
```

Thickness

```
Total thickness : 0.000500 [m]
Ply thickness   : 0.000500 [m]
```

On-axis Modulus and Compliance matrices -- [Q] and [S]

```
S_on [1/GPa] :
[[   0.0132   -0.0045    0.0000]
 [  -0.0045    0.1818    0.0000]
 [   0.0000    0.0000    0.4348]]
U's for S [1/GPa]
U1 :  0.1263
U2 : -0.0843
```

```
U3 : -0.0289
U4 : -0.0333
U5 :  0.3194

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

In-plane Modulus and Compliance -- [A] and [a]

```
A [GN/m] :
[[   0.0081    0.0091    0.0000]
 [   0.0091    0.0167    0.0000]
 [   0.0000    0.0000    0.0093]]
a [m/GN] :
[[ 316.9010 -172.4533   -0.0000]
 [-172.4533  153.7231    0.0000]
 [   0.0000    0.0000  107.5774]]
```

Flexural Modulus and Compliance -- [D] and [d]

```
D [kNm] :
[[   0.0002    0.0002    0.0001]
 [   0.0002    0.0003    0.0002]
 [   0.0001    0.0002    0.0002]]
d [1/MNm] :
[[15530371.6619 -7642652.2161 -1690461.2187]
 [-7642652.2161 8642673.4179 -3364279.7092]
 [-1690461.2187 -3364279.7092 8954671.2946]]
```

Loads

```
N [kN/m] :
[  25.0000   50.0000    0.0000]


e0 [-] :
[-0.00070 0.00337 0.00000]
```

See Appendix A for stresses/strains and safety factors.

Design #2

Chosen layup

[-55/-25/55/25]s

Complete output

Ply orientation list

```
Orientation [degrees] :
[-55, -25, 55, 25, 25, 55, -25, -55]
```

Number of plies

```
8
```

Material properties

```
'          ID :          3  [-]'
'fiber/matrix : E-glass/Epoxy  [-]'
'        name : Fiberglass  [-]'
'          ex :    38.6000  [GPA]'
'          ey :     8.2700  [GPA]'
'          es :     4.1400  [GPA]'
'         nux :     0.2600  [-]'
'          xt :  1062.0000  [MPA]'
'          xc :   610.0000  [MPA]'
'          yt :    31.0000  [MPA]'
'          yc :   118.0000  [MPA]'
'          sc :    72.0000  [MPA]'
'          h0 :     0.1250  [mm]'
'         rho :     1.8000  [g/cm3]'
'         nuy :     0.0557  [-]'
```

Thickness

```
Total thickness : 0.001000 [m]
Ply thickness   : 0.001000 [m]
```

On-axis Modulus and Compliance matrices -- [Q] and [S]

```
S_on [1/GPa] :
[[   0.0259   -0.0067    0.0000]
 [  -0.0067    0.1209    0.0000]
 [   0.0000    0.0000    0.2415]]
U's for S [1/GPa]
U1 :  0.0836
U2 : -0.0475
U3 : -0.0102
U4 : -0.0169
U5 :  0.2009

Q_on [GPa] :
[[  39.1673    2.1818    0.0000]
 [   2.1818    8.3915    0.0000]
 [   0.0000    0.0000    4.1400]]
U's for Q [GPa]
U1 : 20.4500
U2 : 15.3879
U3 :  3.3294
U4 :  5.5112
U5 :  7.4694
```

In-plane Modulus and Compliance -- [A] and [a]

```
A [GN/m] :
[[   0.0212    0.0071    0.0000]
 [   0.0071    0.0166    0.0000]
 [   0.0000    0.0000    0.0090]]
a [m/GN] :
[[  55.0092  -23.4870   -0.0000]
 [ -23.4870   70.3723   -0.0000]
 [  -0.0000   -0.0000  110.6965]]
```

Flexural Modulus and Compliance -- [D] and [d]

```
D [kNm] :
[[   0.0015    0.0006   -0.0004]
 [   0.0006    0.0016   -0.0004]
 [  -0.0004   -0.0004    0.0008]]
d [1/MNm] :
[[858067.0903 -250207.2728 316679.9763]
 [-250207.2728 811552.9001 310409.5587]
 [316679.9763 310409.5587 1612611.0848]]


The ratio of D11 to D22 is :
0.94461988227
```

Design #3

In a Nutshell

```
Material Chosen :
T300/N5208

Orientation [degrees] :
[10, 20, -13, -16, -18, 29, 31, 27, 27, 31, 29, -18, -16, -13, 20, 10]

Number of layers :
16

Weight :
9.6 gram

Minimum safety factor for load I / load II :
2.26 / 2.28
```

Complete output

Ply orientation list

```
Orientation [degrees] :
[10, 20, -13, -16, -18, 29, 31, 27, 27, 31, 29, -18, -16, -13, 20, 10]
```

Number of plies

```
16
```

Material properties

```
'          ID :          1  [-]'
'fiber/matrix : T300/N5208  [-]'
'        name : Graphite/Epoxy  [-]'
'          ex :   181.0000  [GPA]'
'          ey :    10.3000  [GPA]'
'          es :     7.1700  [GPA]'
'         nux :     0.2800  [-]'
'          xt :  1500.0000  [MPA]'
'          xc :  1500.0000  [MPA]'
'          yt :    40.0000  [MPA]'
'          yc :   246.0000  [MPA]'
'          sc :    68.0000  [MPA]'
'          h0 :     0.1250  [mm]'
'         rho :     1.6000  [g/cm3]'
'         nuy :     0.0159  [-]'
```

Thickness

```
Total thickness : 0.350000 [cm]
Ply thickness   : 0.200000 [cm]
```

On-axis Modulus and Compliance matrices -- [Q] and [S]

```
S_on [1/GPa] :
[[   0.0055   -0.0015    0.0000]
 [  -0.0015    0.0971    0.0000]
 [   0.0000    0.0000    0.1395]]
U's for S [1/GPa]
U1 :  0.0555
U2 : -0.0458
```

```
U3 : -0.0042
U4 : -0.0058
U5 :  0.1226

Q_on [GPa] :
[[ 181.8111    2.8969    0.0000]
 [   2.8969   10.3462    0.0000]
 [   0.0000    0.0000    7.1700]]
U's for Q [GPa]
U1 : 76.3682
U2 : 85.7325
U3 : 19.7104
U4 : 22.6074
U5 : 26.8804
```

In-plane Modulus and Compliance -- [A] and [a]

```
A [GN/m] :
[[   0.2830    0.0403    0.0293]
 [   0.0403    0.0323    0.0129]
 [   0.0293    0.0129    0.0489]]
a [m/GN] :
[[   4.3731   -4.9306   -1.3251]
 [  -4.9306   40.1686   -7.6278]
 [  -1.3251   -7.6278   23.2757]]
```

Flexural Modulus and Compliance -- [D] and [d]

```
D [kNm] :
[[   0.4936    0.0553    0.0335]
 [   0.0553    0.0473    0.0129]
 [   0.0335    0.0129    0.0694]]
d [1/MNm] :
[[2359.0757 -2575.6152 -660.3018]
 [-2575.6152 25064.6523 -3420.3223]
 [-660.3018 -3420.3223 15371.9932]]
```

Load Case 1

```
N [N/m]:
[-22400  -3000  -2000]
M [N]:
[-1000  -100  -100]


e0 [-] :
[-0.00008 0.00001 0.00001]
k [-] :
[-2.03548405  0.41118216 -0.53486525]
```

See Appendix B for stresses/strains and safety factors.

Load case 2

```
N [N/m]:
[-20800  -2800  -2200]
M [N]:
[-980  -98 -110]


e0 [-] :
[-0.00007 0.00001 -0.00000]
k [-] :
[-1.98685075  0.44400239 -0.70863186]
```

See Appendix C for stresses/strains and safety factors.