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> # Prof. Dr. Serkan Dağ
# ME 451 Introduction to Composite Structures
> # File 4.5
# Example on engineering constants of an angle lamina
> restart :
  with(LinearAlgebra) :
> # Define lamina angle
> s := sin( (th·Pi) / 180 ) :
  c := cos( (th·Pi) / 180 ) :
> # Define material properties for graphite/epoxy
> E1 := 181.0·103 :
  E2 := 10.3·103 :
  nu12 := 0.28 :
  G12 := 7.17·103 :
> # Find elements of the compliance matrix ( unit=1/(MPa) )
> S11 := 1 / E1 ;
  S12 := - nu12 / E1 ;
  S22 := 1 / E2 ;
  S66 := 1 / G12 ;

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$$\begin{matrix}
5.525 \times 10^{-6} \\
-1.547 \times 10^{-6} \\
9.709 \times 10^{-5} \\
1.395 \times 10^{-4}
\end{matrix}$$

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> # Find elements of the transformed compliance matrix ( unit=1/
(MPa) )
> S11bar := S11·c4 + S22·s4 + (2·S12 + S66)·c2·s2 :
  S12bar := (S11 + S22 - S66)·c2·s2 + S12·(c4 + s4) :
  S16bar := (2·S11 - 2·S12 - S66)·s·c3 - (2·S22 - 2·S12 - S66)·s3·c :
  S22bar := S11·s4 + S22·c4 + (2·S12 + S66)·c2·s2 :
  S26bar := (2·S11 - 2·S12 - S66)·s3·c - (2·S22 - 2·S12 - S66)·s·c3 :
  S66bar := 2·(2·S11 + 2·S22 - 4·S12 - S66)·s2·c2 + S66·(c4 + s4) :
> # Evaluate the engineering constants (Ex, Ey, and Gxy in GPa)
> Ex := 1 / S11bar · 10-3 :
  Ey := 1 / S22bar · 10-3 :
  nuxy := - S12bar / S11bar :

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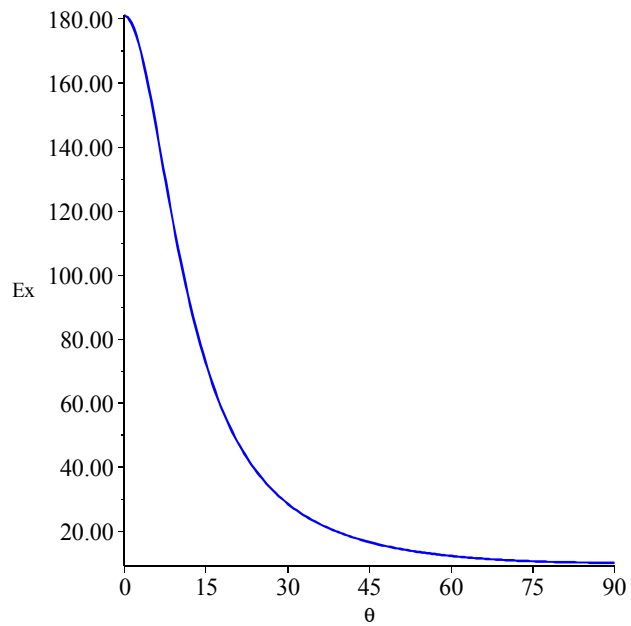
(1)

$$G_{xy} := \frac{1}{S66bar} \cdot 10^{-3} ;$$

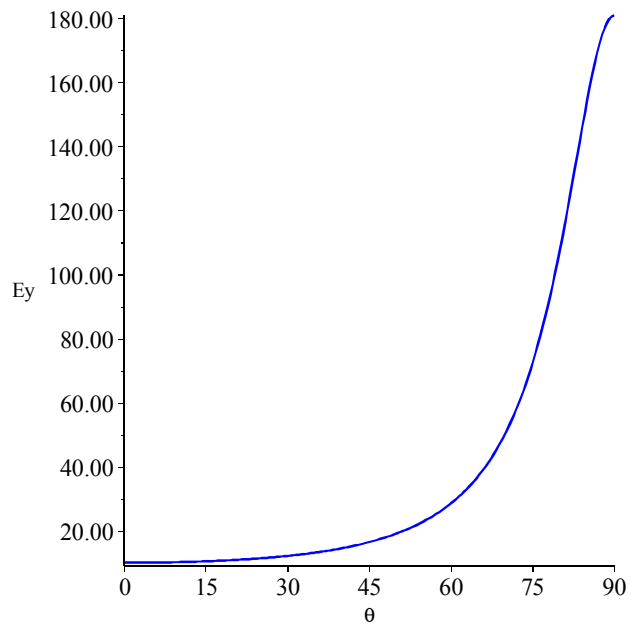
$$m_x := -\frac{S16bar}{S11bar} ;$$

$$m_y := -\frac{S26bar}{S22bar} ;$$

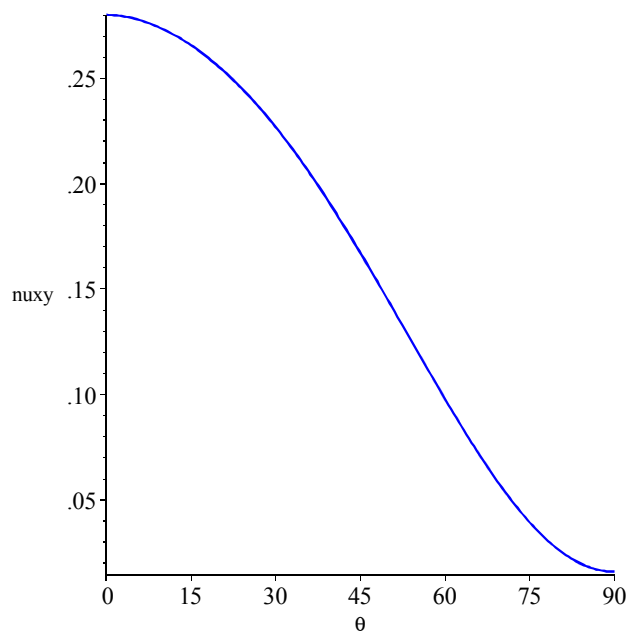
> *plot*(*Ex*, *th* = 0 ..90);



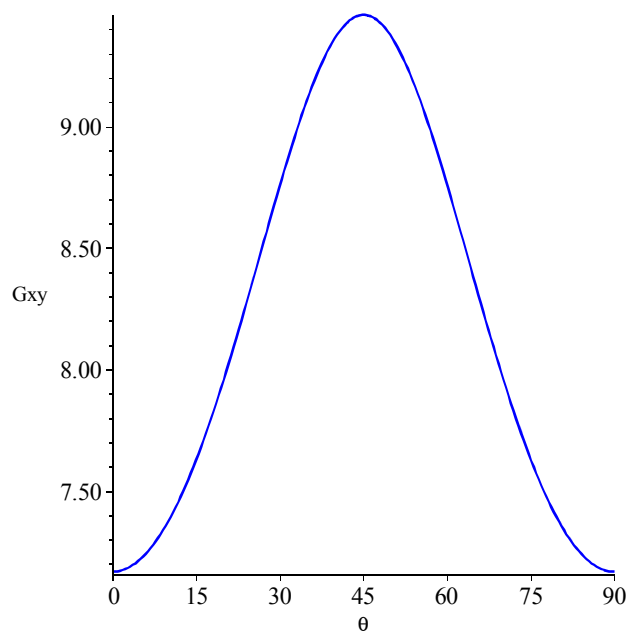
> *plot*(*Ey*, *th* = 0 ..90);



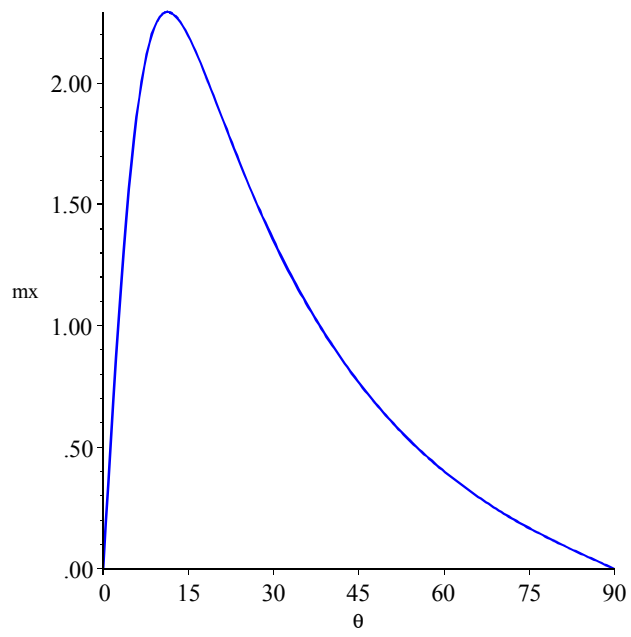
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> plot(nuxy, th = 0 ..90);
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> plot(Gxy, th = 0..90);
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> plot(mx, th=0..90);
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> plot(my, th = 0..90);
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