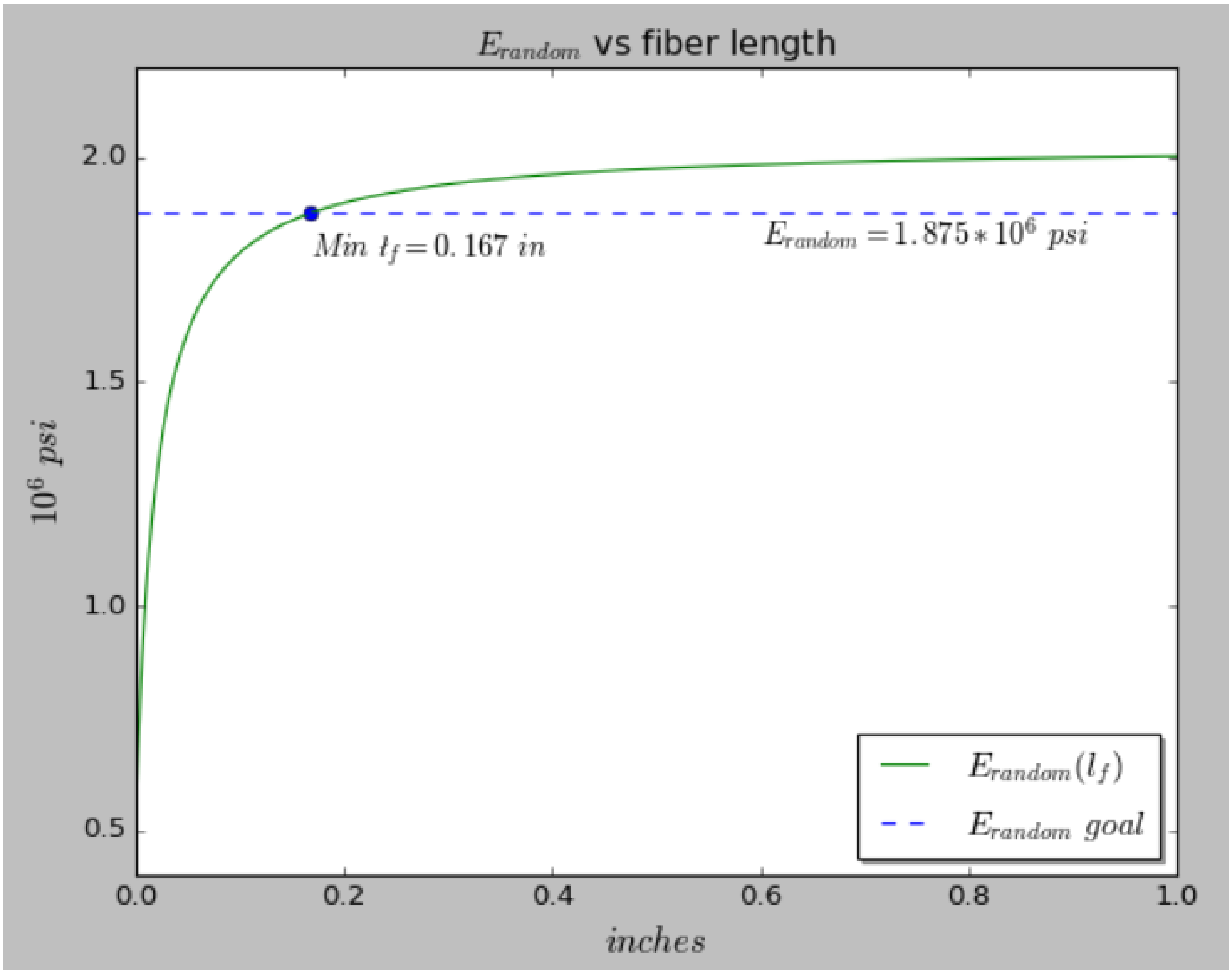
#1

- The new tensile modulus goal is 150% of the previous composite, resulting in Erandom of 1.875 *10^6 psi.
- First need to find the volume fractions from the mass fraction of 20%
- Use Halpin-Tsai equations modified for discontinuous fiber to find E1 and E2
- Substitute in Tsai and Pagano equation for Randomly oriented discontinuous fiber
- Now have an equation with **fiber lengt**h as single variable
- Set 3/8*E1 + 5/8*E2 – Erandom = 0 and solve for **fiber length**

  -1511576.3149403 + 150000.0(33717.0263788969*l_f/(3333.33333333333*l_f + 75.0) + 1)/(1 - 10.1151079136691/(3333.33333333333*l_f + 75.0)) = 0*

- The graph shows the minimum fiber length that will achieve the desired tensile modulus



#2

$$\bar{S}_{0^\circ} = \begin{bmatrix} 2.027e-11 & -5.270e-12 & 0.000e+00 \\ -5.270e-12 & 7.963e-11 & 0.000e+00 \\ 0.000e+00 & 0.000e+00 & 2.295e-10 \end{bmatrix} GPa^{-1}$$

$$\bar{S}_{45^\circ} = \begin{bmatrix} 7.971e-11 & -3.503e-11 & -2.968e-11 \\ -3.503e-11 & 7.971e-11 & -2.968e-11 \\ -2.968e-11 & -2.968e-11 & 1.104e-10 \end{bmatrix} GPa^{-1}$$

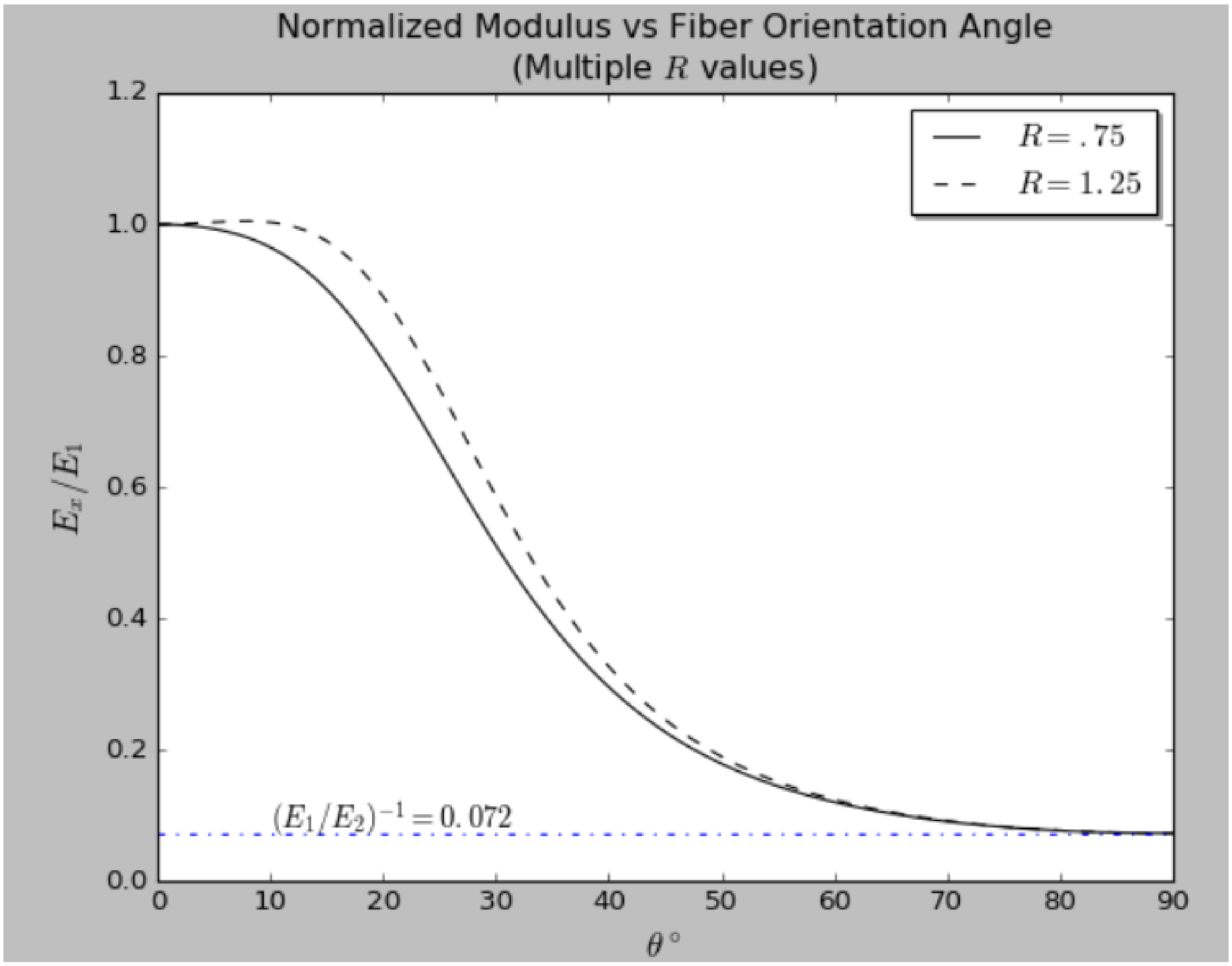
Assuming plane stress for the thin lamina. $\bar{S}_{0^\circ}$ is the same as S since no rotation has occurred.

$\bar{S}_{45^\circ}$ has introduced coupling between tensile and shear components since $\bar{S}_{16,\,45^\circ}$ and $\bar{S}_{26,\,45^\circ}$ are non-zero. We also see that the two tensile modulus values have become equal at 45º.

#3

Ex/E1 = 1/(E1*n**4/E2 + m**4 + m**2*n**2*(-2*v12 + (2*v12 + 2)/R))

Solved with algebraic system, see code #3 (includes assumptions about properties)



We can see that higher values of R result in equal or higher tensile modulus values across all orientation angles. As expected, both normalized modulus are 1 at 0°, since no transformation has occurred yet, so it is equivalent to E1/E1. Additionally, we see that Ex/E1 approaches E2/E1 as theta goes to 90°, which occurs since E1 and E2 are 90° apart.