Q- A polarizer is followed by n analyzers, each tilted by 0.54 degree with respect to the pervious. How many analyzers are required to reduce the intensity by a factor of 1/50 that which is entering the polarizer?

The light after passing through a polarizer gets polarized. When polarized light passes through another polarizer, called analyzer, whose axis is tilted, the intensity of the light passed is decreases due to decrease in the amplitude of the electric field as $E = E_0 \cos\theta$ where $\theta$ is the angle between the axes of the polarizer and the and analyzer. As the intensity of the light is proportional to the square of amplitude, the is proportional $\cos^2\theta$ and given by

$$I = I_0 * \cos^2\theta$$

Where $I_0$ is the intensity of the incident polarized light.

This is called the law of Malus.

Here each analyzer is tilted by an angle $\theta = 0.54^0$ with the previous one the intensity of the transmitted light is decreases with each analyzer.

Let the intensity of the light from the polarizer is $I_0$ then the intensity of light after passing through the first analyzer is given by

$$I_1 = I_0 * \cos^2\theta$$

And when this light is passed through second analyzer, the intensity becomes

$$I_2 = I_1 \cos^2\theta = I_0 * \cos^2\theta * \cos^2\theta = I_0 * \cos^4\theta$$

And when this light is passed through the third analyzer its intensity will be

$$I_3 = I_2 \cos^2\theta = I_0 * \cos^4 * \cos^2\theta = I_0 * \cos^6\theta$$

Hence after passing through n analyzer the intensity of emerging beam will be given by

$$I_n = I_{n-1} \cos^2\theta = I_0 * \cos^{2n}\theta$$

Or $$I_n / I_0 = \cos^{2n}\theta$$

But as the intensity becomes 1/50 of the initial we have

$$\frac{I_n}{I_0} = \frac{1}{50} = \cos^{2n}(0.54^0)$$

Gives $$0.02 = \left(\cos 0.54^0\right)^{2n}$$

Or $$2n = \frac{\ln 0.02}{\ln\left(\cos 0.54^0\right)} = \frac{-3.9120}{-4.4413 * 10^{-5}} = 88081.1$$

Or $$n = 44040.5$$

Hence **44041** analyzers are required to reduce the intensity by a factor 1/50.