Math for Laser and Optics Technicians

Geometry

Angle Measurements

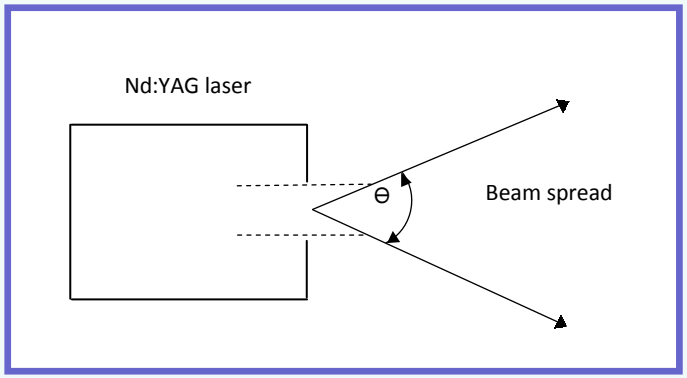
Photonics technicians need to perform calculations using angles measured in both degrees and radians, converting between the two, if necessary, by using the equivalency between 2π radians and 360 degrees. They also need to calculate partial solid angles (in three dimensions), such as the solid angle subtended by a beam of light emanating and spreading out from a point source of light.

EXAMPLE

Laser light exiting an Nd:YAG laser passes through an exit aperture (opening) at the output laser mirror of diameter 1 millimeter. The wavelength of light for an Nd:YAG laser is 1.06 μm. You have learned that the beam spread of light of wavelength, λ, through a circular opening of diameter, *D*, is given by the equation.

$$\Theta = 1.27\frac{\lambda}{D}$$

Where Θ is the beam angle spread (called divergence) and is given in radian measure.



Question

For this laser, determine the beam spread angle in both radians and degrees.

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Solution to Geometry Question

Beam spread angle Θ in radians is given $\Theta = 1.27\frac{\lambda}{D}$

Therefore, $\Theta_{rad} = \dfrac{(1.27)(1.06 \times 10^{-6}\ \cancel{m})}{1 \times 10^{-3}\ \cancel{m}} = 1.35 \times 10^{-3}$ radians

$= 1.35$ milliradians

Now, converting to degrees:

$$\frac{1.35 \times 10^{-3}\ \cancel{rad} \quad | \quad 180°}{\qquad\qquad\quad | \quad \pi\ \cancel{rad}} = 0.077°$$

The beam spread of laser beams (here less than one tenth of a degree!) is much smaller than that of flashlights, searchlights, and so on.

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