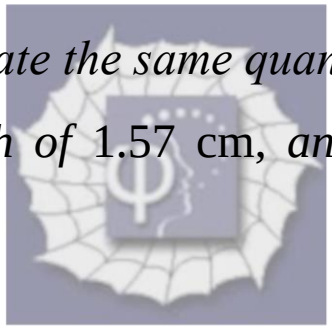
**663.**

**Problem 46.27 (RHK)**

*Millimetre-wave radar generates a narrower beam than conventional microwave radar. This makes it less vulnerable to antiradar missiles.* (a) *We have to calculate the angular width, from first minimum to first minimum, of the central "lobe" produced by a* 220-GHz *radar beam emitted by a* 55-cm *diameter circular antenna.* (b) *We have to calculate the same quantity for a ship's radar with a wavelength of* 1.57 cm, *and a* 2.33 m *diameter antenna.*



**Solution:**

The wavelength of radar waves of 220-GHz frequency is

$$\lambda = \frac{3\times10^{8}}{220\times10^{9}}\ \text{m} = 1.36\times10^{-3}\ \text{m} = 1.36\ \text{mm}.$$

In a diffraction pattern from a circular antenna of diameter *d*, the angular position of the first minima is given by the relation

$$\sin\theta = \frac{1.22\lambda}{d}.$$

As the diameter of the antenna is

$d = 55 \text{ cm} = 0.55 \text{ m},$

we note that

$$\sin\theta = \frac{1.22 \times 1.36 \times 10^{-3}}{0.55} = 3.0 \times 10^{-3},$$

$$\therefore \ \theta \ ; \ 3.0 \times 10^{-3} \text{ rad} = 0.173^{0}.$$

Therefore, the angular width of the central “lobe” will be $0.346^{0}$.

(b)

In the second part of the problem the relevant data are

$\lambda = 1.57 \text{ cm} = 1.57 \times 10^{-2} \text{ m},$

and

$d = 2.33 \text{ m}.$

We have

$$\sin\theta = \frac{1.22 \times 1.57 \times 10^{-2}}{2.33} = 8.22 \times 10^{-3},$$

and

$\theta \ ; \ 8.22 \times 10^{-3} \text{ rad} = 0.47^{0}.$

The angular width of the central “lobe” will be $0.94^{0}$.