1 Practice Problems

Ansys

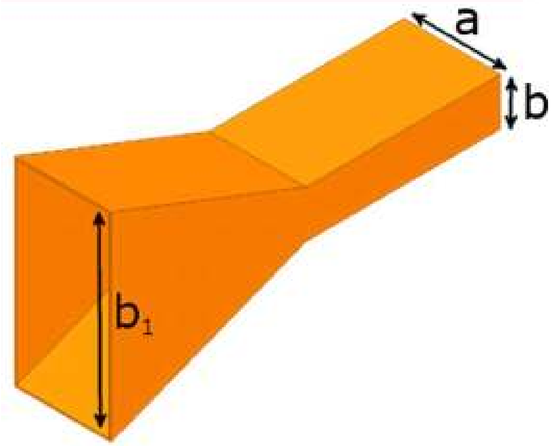
Practice Problem 1

1. Find the flare angle of an E-plane sectoral horn antenna such that the maximum phase deviation across the aperture is 60° and with physical dimensions of $a = 0.75\lambda$, b $= 0.25\lambda$, and $b_1 = 1\lambda$

- $\Delta\phi_{max} = k\delta(y')\big|_{y'={b_1}/{2}} = \dfrac{k\left({b_1}/{2}\right)^2}{2\rho_1}$
- $(60^{\circ})\left(\dfrac{\pi}{180}\right) = \dfrac{k\left({b_1}/{2}\right)^2}{2\rho_1}$
- $\dfrac{k}{2\rho_1} = \left(\dfrac{60\pi}{180}\right)\left(\dfrac{4}{b_1^2}\right)$
- $\dfrac{1}{\rho_1} = \left(\dfrac{60\pi}{180}\right)\left(\dfrac{8}{kb_1^2}\right)$
- $\rho_1 = \left(\dfrac{180}{60\pi}\right)\left(\dfrac{(2\pi\lambda)b_1^2}{8}\right) = \left(\dfrac{180}{60}\right)\left(\dfrac{\lambda b_1^2}{4}\right) = 0.75\lambda$

$$\Delta\phi_{max} = k\delta\,(y')\Big|_{y'} = \frac{ky'^2}{2\rho_1}$$

$$2\psi_e = 2\tan^{-1}\left(\frac{{b_1}/{2}}{\rho_1}\right)$$



Practice Problem 1 cont.

- $2\psi_e = 2\tan^{-1}\left(\frac{b_1/_2}{\rho_1}\right)$
- $2\psi_e = 2\tan^{-1}\left(\frac{0.5}{0.75}\right)$
- $2\psi_e = 67.38^{\circ}$

Practice Problem 2

2. Design a Yagi antenna using a half-wave dipole as the driven element with one reflector and one director, as well as find the ${}^{F}/_{B}$ ratio given the forward and backward power of $P_f = 20dB$ and $P_b = -5dB$ at 5GHz

$${}^{F}/_{B} = 10\log\left({}^{P_f}/_{P_b}\right)$$
$$RE = 1.05 * DE$$
$$DI = 0.95 * DE$$

- $DE = 0.5\lambda = 0.5\left(\frac{c}{5GHz}\right) = 30mm$
- $RE = 1.05(30mm) = 33mm$
- $DI = 0.95(30mm) = 27mm$
- ${}^{F}/_{B} = 10\log({}^{20dB}/_{-5dB}) = 10\log({}^{10}/_{0.562})$
- ${}^{F}/_{B} = 12.503dB$

Practice Problem 3

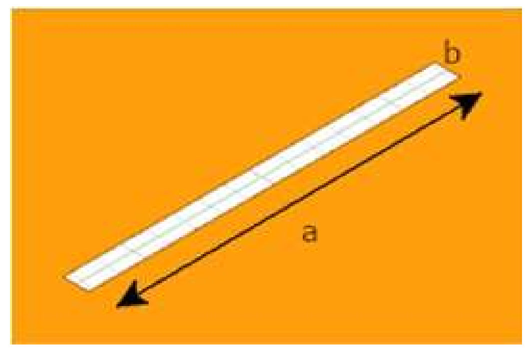
3. With a rectangular aperture situated on a ground plane with lengths $a = 4\lambda$ and b $= 1.5\lambda$, find the directivity, half power bandwidth, and first null beam width at 10GHz

- $D_0 = \frac{4\pi}{\lambda^2}\, Area = \frac{4\pi ab}{\lambda^2} = \frac{4\pi(4\lambda)(1.5\lambda)}{\lambda^2}$
- $D_0 = 4\pi(4)(1.5) = 75.4$
- $HPBW = \frac{50.6}{b/\lambda} = \frac{50.6}{(1.5\lambda)/\lambda} = \frac{50.6}{1.5} = 33.33^\circ$
- $FNBW = \frac{114.6}{b/\lambda} = \frac{114.6}{(1.5\lambda)/\lambda} = \frac{114.6}{1.5} = 76.4^\circ$

$$D_0 = \frac{4\pi}{\lambda^2}\, Area$$

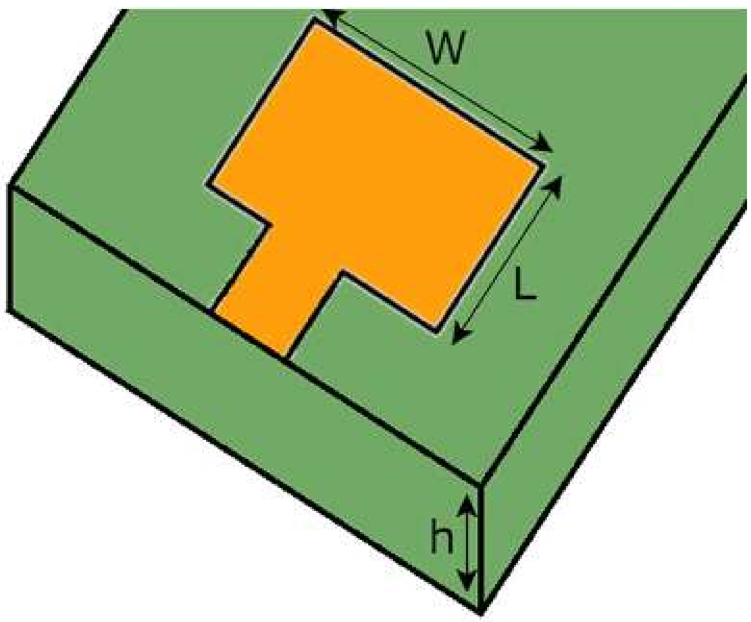
$$HPBW = \frac{50.6}{b/\lambda}$$

$$FNBW = \frac{114.6}{b/\lambda}$$



Practice Problem 4

4. Design a rectangular, microstrip patch antenna placed on a substrate with $\varepsilon_r = 2.5$ and thickness of $h = 5mm$ at 5GHz, with no inset feeding



$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\frac{1}{\sqrt{1 + 12\,{}^{h}/_{W}}}$$

$$W = \frac{\lambda}{2}\sqrt{\frac{2}{\varepsilon_r + 1}}$$

$$\Delta L = 0.412h\frac{\varepsilon_{reff} + 0.3\left({}^{W}/_{h} + 0.264\right)}{\varepsilon_{reff} - 0.258\left({}^{W}/_{h} + 0.8\right)}$$

$$L = \frac{\lambda}{2\sqrt{\varepsilon_{reff}}} - 2\Delta L$$

Practice Problem 4 cont.

- $W = \frac{\lambda}{2}\sqrt{\frac{2}{\varepsilon_r+1}} = \frac{(0.06m)}{2}\sqrt{\frac{2}{(2.5)+1}}$
- $W = 22.68mm$
- $\varepsilon_{reff} = \frac{(2.5)+1}{2} + \frac{(2.5)-1}{2}\frac{1}{\sqrt{1+12^{(5mm)}/_{(22.68mm)}}}$
- $\varepsilon_{reff} = 2.143$
- $\Delta L = 0.412(5mm)\frac{(2.143)+0.3\left(^{(22.68mm)}/_{(5mm)}+0.264\right)}{(2.143)-0.258\left(^{(22.68mm)}/_{(5mm)}+0.8\right)}$
- $\Delta L = 9.63mm$
- $L = \frac{\lambda}{2\sqrt{\varepsilon_{reff}}} - 2\Delta L = \frac{(0.06m)}{2\sqrt{(2.143)}} - 2(9.63mm)$
- $L = 1.23mm$