EE307 Homework 8

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Problem： A small parabolic reflector of 1 m diameter is operated at 3 GHz. The taper efficiency is 80 percent; The spill over efficiency is 85 percent. Assume no other losses. Find

a) The total efficiency of the antenna in dB.

b) The directivity in dB.

Solution：

a) The total efficiency of the antenna in dB.

- **Firstly, according to the formula table, the taper efficiency and spill over efficiency can be calculated as:**

$$\varepsilon_t = 32\left(\frac{f}{d}\right)^2 \frac{\left|\int_0^{\theta_0}\sqrt{G_f(\theta')}\tan\left(\frac{\theta'}{2}\right)d\theta'\right|}{\int_0^{\theta_0} G_f(\theta')\sin\theta' d\theta'} = 2\cot^2\left(\frac{\theta_0}{2}\right)\frac{\left|\int_0^{\theta_0}\sqrt{G_f(\theta')}\tan\left(\frac{\theta'}{2}\right)d\theta'\right|}{\int_0^{\theta_0} G_f(\theta')\sin\theta' d\theta'} = 0.8$$

$$\varepsilon_s = \frac{\int_0^{\theta_0} G_f(\theta')\sin\theta' d\theta'}{\int_0^{\pi} G_f(\theta')\sin\theta' d\theta'} = 0.85$$

- **Then, according to the course ppt, we also know the total efficiency can be calculated as:**

$$\eta_t = \eta_i \cdot \eta_s \cdot \eta_p \cdot \eta_x \cdot \eta_b \cdot \eta_r = \varepsilon_t \cdot \varepsilon_s \cdot \eta_p \cdot \eta_x \cdot \eta_b \cdot \eta_r$$

- **Next, because there are no other losses, that means all the other η will become 1. So the total efficiency of the antenna will become:**

$$\eta_t = \eta_i \cdot \eta_s \cdot \eta_p \cdot \eta_x \cdot \eta_b \cdot \eta_r = \varepsilon_t \cdot \varepsilon_s = 0.8 \times 0.85 = 0.68 = 68\%$$

- **Finally, we convert the result in to dB, that is:**

$$\eta_t = 68\% = 0.68 = 10\log_{10} 0.68 \approx -1.675\ dB$$

- **Therefore, the total efficiency of the antenna in dB is -1.675.**

b) The directivity in dB.

- **According to the formula in course ppt, the directivity can be calculated as:**

$$D_0 = \left(\frac{\pi \cdot d}{\lambda}\right)^2 \varepsilon_{ap} = \left(\frac{\pi \cdot d}{\lambda}\right)^2 \eta_t$$

- **Therefore, in this problem, we can calculate the directivity in dB as:**

$$D_0 = \left(\frac{\pi \cdot d}{\lambda}\right)^2 \eta_t = \left(\frac{\pi \cdot d \cdot f}{c}\right)^2 \eta_t = \left(\frac{\pi \times 1 \times 3 \times 10^9}{2.998 \times 10^8}\right)^2 \times 0.68 \approx 672.03 \approx 28.27\ dB$$

- **Therefore, the directivity in dB is 28.27.**