# EE 483/583 Antennas for Wireless Communications
## Quiz #3 (Spring 2017)

**Name** Key A

Instructions: Open book & notes. Place answers in indicated spaces and show all work for credit.

At 8.5 GHz, a vertically-polarized WR-90 X-band rectangular horn antenna has a gain of 14.4 dBi. The physical aperture of the horn is 7 cm by 16.2 cm. Find the maximum effective aperture (in $cm^2$) and aperture efficiency (in %) at this frequency. If a vertically-polarized EM plane wave with a power density of 500 $\mu W/m^2$ is incident from the direction of maximum gain, how much power is available to a matched load? If the horn antenna is tipped 20° from vertical, how much power will be received?

Per (2-110), $A_{em} = \frac{\lambda^2}{4\pi} D_0$

$\lambda = c/f = \frac{299,792,458}{8.5 \times 10^9} = 0.03527\ m = 3.52697\ cm$

$D_0 = 14.4\ dBi = 10^{14.4/10} = 27.542287$

$A_{em} = \frac{3.52697^2}{4\pi}(27.542287) = \underline{27.26426\ cm^2} =$

Per (2-100), the aperture efficiency is

$\epsilon_{ap} = \frac{A_{em}}{A_p} = \frac{27.26426\ cm^2}{(7\ cm)(16.2\ cm)} = 0.2404 = \underline{24.0426\ \%}$

Per (2-94), the available power can be found

$A_e = P_T/W_i \Rightarrow P_{T,max} = A_{em} W_i = (0.0027264\ m^2)(500 \times 10^{-6}\ W/m^2)$

$= \underline{1.363213 \times 10^{-6}\ W}$

Per (2-112), we can modify $A_{em}$ to include PLF

$P_{T,max,20°} = A_{em}(PLF) W_i = (0.0027264)(\cos^2 20°)\ 500 \times 10^{-6}$

$= \underline{1.203747 \times 10^{-6}\ W}$

max. eff. aperture = 27.2643 $cm^2$ aperture efficiency = 24.043 %

power available, vertical = 1.3632 $\mu W$ power available, 20° = 1.2037 $\mu W$