4.31 A base-station cellular communication system utilizes arrays of $\lambda/2$ dipoles as transmitting and receiving antennas. Assuming that each element is *lossless* and that the *input power* to each of the $\lambda/2$ dipoles is 1 watt, determine at *1,900 MHz* and a distance of *5 km* the maximum

(a) radiation intensity. *Specify also the units.*

(b) radiation density (*in watts/m*^{2})

for each $\lambda/2$ *dipole*. This determines the safe level for human exposure to EM radiation.

Lossless $\Rightarrow P_{in} = P_{rad} = 1\,W$

per (4-91), $D_{max} = D_0 = 1.643$ for a $\lambda/2$ dipole

a) To find maximum radiation intensity, use

(2-16a) $D_{max} = D_0 = \dfrac{4\pi U_{max}}{P_{rad}}$

$\hookrightarrow U_{max} = \dfrac{P_{rad}}{4\pi} D_{max} = \dfrac{1\,W}{4\pi} 1.643$

$$U_{max} = 0.13075\ W/sr$$

b) To find maximum radiation density, use

(2-12) $U = r^2 W_{rad}$

$\hookrightarrow W_{rad} = U/r^2 \Rightarrow W_{rad,max} = \dfrac{U_{max}}{r^2}$

$$= \frac{0.130746}{5000^2}$$

$$W_{rad,max} = 5.2298 \times 10^{-9}\ W/m^2$$