ECE 4370: Antenna Engineering
Solutions to TEST 2 (Fall 2017)

1. Small-Scale Fading

   (a) The -90 dBm threshold occurs in the linear scale at 1×10^{-9} millWatts.

   $$\frac{1}{P_{av}} \int_0^{1\times10^{-9}} \exp\left(-\frac{p}{P_{av}}\right) dp = 1 - \exp\left(-\frac{1\times10^{-9}}{P_{av}}\right) = .01$$

   implying that P_{av} is -70 dBm.

   (b) You could use three separate antennas in a space diversity scheme. If they were separated by enough space, the total propability of simultaneous fade for all three channels is 1×10^{-6}.

2. **Antenna Arrays:** Place 4 elements along the x-axis, separated by $\lambda/2$ and with a linear phase taper of $\pi/3$. The maximum occurs when the denominator is minimized such that $\cos\phi = -1/3$ or $\phi = 109.5^\circ$ and 250.5°.

3. **Propagation Modeling:**

   (a) With 1 tree, 1 outer wall, and two inner walls, the Seidel-Rappaport model results in a received power of -68.7 dBm.

   (b) The same received power in part (a) would be predicted by the path loss exponent model for $n = 4.59$.

4. **Antenna Types:**

1.	V-Dipole	h	5.	Uniform Linear Array	f
2.	Open Waveguide	c	6.	Pyramidal Horn	g
3.	Vivaldi Antenna	a	7.	Log-Periodic	e
4.	Yagi-Uda Array	b	8.	Uniform Planar Array	d

5. **Helical Design:** Design equations mandate:

$$G_{\text{peak}} = 15N\frac{C^2S}{\lambda^3} \geq 12.6 \quad \text{HPBW} = \frac{52\lambda^{3/2}}{C\sqrt{NS}} \geq 20^\circ \quad \text{AR} \geq \frac{2N}{2N+1} \geq 1.35 \quad \alpha = \tan^{-1}(S/C) = 13^\circ$$

Thus, $C = \lambda = 6$ cm, $S = 1.3$ cm, N must be at least 30 to achieve the beamwidth criterion. With this many turns, the AR will only be 0.07 dB – near-perfect circular polarization.