

# Tutorial 2

## Chapter 4

9. What is the magnitude of the diffracted wave off a  $\lambda/50$  radius of curvature knife edge when the incident wave has magnitude 1 and a 15 degree shadow angle from the edge?
17. For a 5 GHz radar, what is the loss through a single concrete block wall?
18. What is the additional range delay over free space for a wave propagating through two 12 inch thick walls with refractive index of 5?

## Chapter 5

4. Consider two radar targets with polarization scattering matrices  $S_1$  and  $S_2$  as follows:

$$S_1 = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}, \quad S_2 = \begin{bmatrix} 1 & j \\ -j & -1 \end{bmatrix}$$

where  $j = \sqrt{-1}$ . Compute the parallel/cross-polarization ratio and the vertical/horizontal polarization ratio for each target. Which ratio could be used to discriminate between the two targets?

8. A radar collects  $N_t = 30$  samples of clutter data having a decorrelation time  $\tau_0$  of 200  $\mu$ s. What is the number of uncorrelated samples  $N_i$  if the PRF is 1 kHz? Repeat for PRF = 5 kHz and 40 kHz.
10. Use equations (5.28) and (5.29) to confirm that a reflectivity  $\eta = -92$  dB corresponds to a meteorological reflectivity of 23 dBz at S-band (3 GHz) as shown in Table 5-8.

**TABLE 5-8** ■ Average Rain Reflectivity versus Frequency Band

Z, dBz	Type	Radar band:	$\eta$ , dB m <sup>-1</sup>						
			Transmit frequency, GHz						
			S 3.0	C 5.6	X 9.3	K <sub>u</sub> 15.0	K <sub>a</sub> 35	W 95	mm 140
-12	Heavy stratus clouds					-100	-85	-69	-62
14	Drizzle, 0.25 mm/h		-102	-91	-81	-71	-58	-45*	-50*
23	Light rain, 1 mm/h		-92	-81.5	-72	-62	-49	-43*	-39*
32	Moderate rain, 4 mm/h		-83	-72	-62	-53	-41	-38*	-38*
41	Heavy rain, 16 mm/h		-73	-62	-53	-45	-33	-35*	-37*

\* Approximate

Source: From Nathanson [15] (with permission).

$$\eta = \frac{\pi^5 |K|^2}{\lambda^4} Z \quad (5.28)$$

$$Z \text{ (dBz)} = 10 \log_{10}(10^{18} Z) = 10 \log_{10}(Z) + 180 \quad (5.29)$$

## Chapter 6

14. For an EM wave propagating toward a PEC surface, what happens to the impedance of the wave very close to the PEC surface?
15. In world of computational EM, if an aircraft model has its fuselage along the x axis and its wings parallel to the x-y plane, what spherical unit vectors correspond to horizontal and vertical polarization for an angle cut in the x-y plane?
22. In high-frequency scattering, why does the backscatter RCS usually vary so rapidly with target movement?