UNIVERSITY OF MANITOBA

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

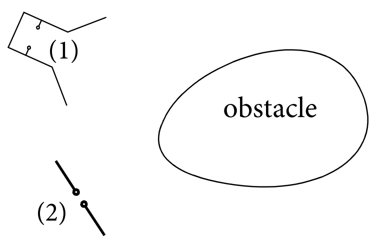
24.8200 Engineering Electromagnetics

ASSIGNMENT 8

Due Date: Thursday December 14, 2006 **Instructor: J. LoVetri**

---

1) (Harrington: Problem 3-24) Let the figure below represent two antennas in the presence of an obstacle. Let V_1 be the voltage received at antenna 1 when a unit current source is applied at antenna 2 and V_2 be the voltage received at antenna 2 when a unit current source is applied at antenna 1. Let V_1^i and V_2^i be the corresponding voltages when the obstacle is absent. Define the scattered voltages as $V^s = V - V^i$ and show that $V_1^s = V_2^s$.



2) (Harington: Problem 3-20) Consider a rectangular PEC plate in the yz-plane of width a in the y-direction and b in the z-direction, centred at the origin. Let the incident plane-wave, polarized in the z-direction, be specified by $E_z^i = E_0 e^{jk(x\cos\phi_0 + y\sin\phi_0)}$, where ϕ_0 is a constant angle measuring the angle of incidence from the z-axis. Use the induction theorem with the same approximation as was used in the problem of Fig. 3-17, and show that at large r, *i.e.*, the distance from the origin, the scattered field in the xy-plane is

$$E_z(r, \phi)^s \approx \frac{kE_0 ab e^{-jkr}}{j2\pi r} \frac{\sin[k(a/2)(\sin\phi_0 + \sin\phi)]}{k(a/2)(\sin\phi_0 + \sin\phi)} \cos\phi\,,$$

where ϕ is the angle measured from the z-axis. Show that the echo area is

$$A_e \approx 4\pi\left[\frac{ab(\cos\phi_0 \sin ka \sin\phi_0)}{\lambda ka \sin\phi_0}\right]^2.$$

[Harrington, on p. 116, defines echo area thus: "The *echo area* or *radar cross section* of an obstacle is defined as the area for which the incident wave contains sufficient power to produce, by omnidirectional radiation, the same back-scattered power density. In mathematical form, the echo area is

$$A_e = \lim_{r \to \infty} (4\pi r^2 \bar{\mathbb{S}}^s / \bar{\mathbb{S}}^i)\,.$$

Where $\bar{\mathbb{S}}^i$ is the incident power density and $\bar{\mathbb{S}}^s$ is the scattered power density."]