ECE 6345
Spring 2015

Homework 5

1) A rectangular microstrip antenna is printed on a lossless substrate having a substrate relative permittivity ε_r = 2.2. The aspect ratio of the patch is $W/L = 1.5$. The antenna is operated at the resonant frequency (assume that fringing may be ignored, so the length of the patch is one-half of a wavelength in the dielectric). Plot the exact Q_{sp} versus the normalized substrate thickness h / λ_0 over the range $0 < h / \lambda_0 < 0.1$. On the same graph, add a plot of the CAD result for Q_{sp} (which involves the CAD formula for p). The exact Q_{sp} is based on the exact P_{sp}, which comes from the exact power radiated by the equivalent dipole (which involves a single integration in θ) and the exact p factor (which must be found from a double integration in θ and ϕ.

2) Redo the above problem for a substrate relative permittivity of 10.8.

3) Consider the rectangular patch of Prob. 1. Plot the exact directivity (dB) versus the normalized substrate thickness h / λ_0 over the range $0 < h / \lambda_0 < 0.1$. On the same graph, add a plot of the CAD results for the directivity (from a closed-form expression, which uses the CAD formula for p).

4) Redo the previous problem for a substrate relative permittivity of 10.8.

5) A circular microstrip antenna is printed on a lossless substrate having a substrate relative permittivity ε_r = 2.2. The antenna is operated at the resonance frequency of the TM_{011} mode. Ignore fringing, so that

   $$a = 0.29304 \lambda_0 / \sqrt{\varepsilon_r} \ .$$

   Plot the exact Q_{sp} versus the normalized substrate thickness h / λ_0 over the range $0 < h / \lambda_0 < 0.1$. On the same graph, add a plot of the CAD result for Q_{sp} (which uses the CAD formulas for p and I_0). The exact Q_{sp} must be found from a numerical integration in θ.

6) Redo the previous problem for a substrate relative permittivity of 10.8.

7) Consider the circular patch of Prob. 4. Plot the exact directivity (dB) versus the normalized substrate thickness h / λ_0 over the range $0 < h / \lambda_0 < 0.1$. On the same graph, add a plot of the CAD result for the directivity (from a closed-form expression, which uses the CAD formula for p).

8) Repeat the previous problem using a substrate permittivity of 10.8.