ECE 604 Electromagnetic Field Theory

Fall 2019

Homework No. 9. Due Date: Nov 8, 2019.

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Read lecture notes 1-29.

1. (i) Go through the Lecture 27 and derive the expression (1.6).
(ii) Repeat Case II of the same lecture notes, but with N=5, and plot the far field pattern of this new array.
(iii) Find the leading order approximation, up to the quadratic term, of the expression $|\mathbf{r}-\mathbf{r}'|$ when $r'<<r$. In other words, rederive equation (2.7) and reconfirm the definition of Rayleigh distance in (2.10). Also, derive the Rayleigh distance defined in (2.12) of the revised lecture notes.

2. (i) Explain why a folded dipole has a lower resonant frequency.
(ii) Explain how a cavity backed slot antenna work.
(iii) Explain why the corrugated horn antenna produce an axially symmetric radiation pattern.
(iv) Explain how a lens antenna work.
(v) Explain why PIFA is smaller than a half-wave dipole.
(vi) Explain how you would made the current uniform on a large loop antenna.

3. When magnetic current and magnetic charge are added to Maxwell's equations, they become highly symmetrical.
(i) In the manner of Lecture 23, shows that when the magnetic current and charge are present, one can define electric vector potential and magnetic scalar potential and derive the fields due to these sources in a similar manner.
(ii) Describe how you would engineer a magnetic dipole that is the dual of the electric Hertzian dipole.
(iii) Derive the far field of this magnetic dipole antenna. Describe its similarity and difference from the far field of an electric dipole.
Hint: Many textbooks (Kong, Ramo et al) tell you how to make a magnetic dipole, and you may find your answer there.