November 16, 2005 Duration: 50 minutes	EE351 Midterm Exam. # 2 (Closed notes & book)	Fall 2005 School of EECS/ WSU
Name:---	ID #: ---	

- Answer all questions
- Closed books
- Closed notes
- No crib notes
- Calculators not allowed
- No headphons, cell phones, or pagers.
- No hats
- No guests or vistors during exam.
- See attached equation sheets.

Signature:____

Problem 1:

The magnetic filed due an antenna in free space is given by

$$\overline{H} = \frac{I_o}{2\pi r} e^{-j\beta r} \sin\theta(\hat{a}_\phi)$$

Determine the following:

(a) The electric field vector $\overline{E}$

(b) The time average power vector $\overline{P}_{ave}$

(c) The radiated power P_{rad}

(d) Radiation resistance R_{rad}

(e) Directive gain $D(\theta,\phi)$:

(f) Directivity D_o

Problem 2:
The plots of the normalized array factors $|AF_n|$ of three antenna arrays of isotropic radiators spaced at $d = \lambda/2$, are shown below. It is known they include broadside and endfire arrays. Answer the following questions:

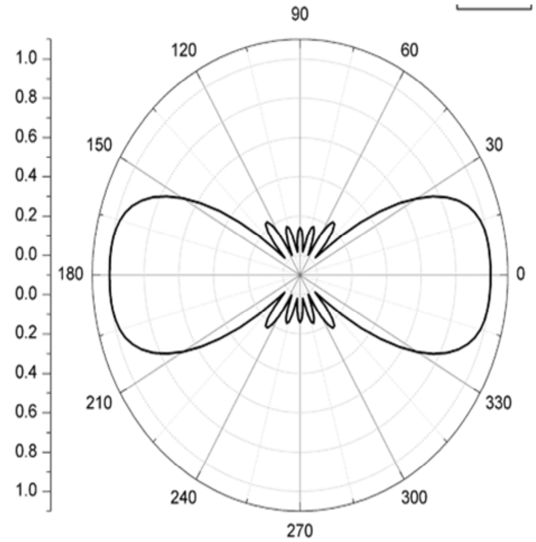


Figure (a): (7)

(i) The array is:
- (a) broadside,
- (b) endfire,
- (c) None of the above

(ii) Number of elements N =

(iii) Phase angle is
- (a) 0^o ,
- (b) 180^o ,
- (d) none of the above

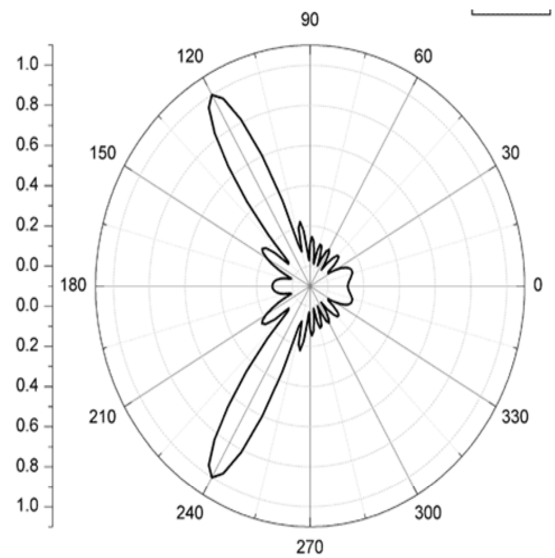


Figure (b): (7)

(i)The array is:
- (a) broadside,
- (b) endfire,
- (c) None of the above

(ii) Number of elements N =

(iii) Phase angle α is
- (a) 0^o ,
- (b) 180^o ,
- (d) none of the above

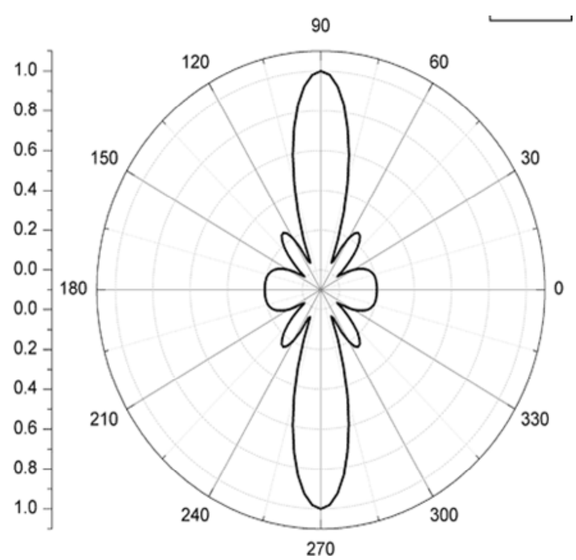


Figure (c): (11)

(i) The array is:
- (a) broadside,
- (b) endfire,
- (c) None of the above

(ii) Number of elements N =

(iii) Phase angle α is
- (a) 0^o ,
- (b) 180^o ,
- (d) none of the above

(iv) The expression for $|AF|$ is:

$|AF| =$

Problem 3:

The electric and magnetic fields from a Hetzian dipole antenna at the origin are given by:

$$E = E_r \hat{a}_r + E_\theta a_\theta \text{ , where}$$

$$E_r = \frac{I_o \Delta l}{4\pi} \eta \cos\theta \left[\frac{1}{r^2} - \frac{j}{\beta r^3} \right] e^{-j\beta r}$$

$$E_\theta = \frac{I_o \Delta l}{4\pi} \eta \sin\theta \left[\frac{j\beta}{r} + \frac{1}{r^2} - \frac{j}{\beta r^3} \right] e^{-j\beta r}$$

$$H = H_\phi \hat{a}_\phi = \frac{I_o \Delta l}{4\pi} \sin\theta \left[\frac{j\beta}{r} + \frac{1}{r^2} \right] e^{-j\beta r} \hat{a}_\phi$$

a: Derive expressions for approximate forms of E and H in the **near zone** (close to antenna) :

$E_r =$

$E_\theta =$

$H_\phi =$

b: Derive expressions for approximate forms of E and H in the **far zone** (these are known as radiation fields)?

$E_r =$

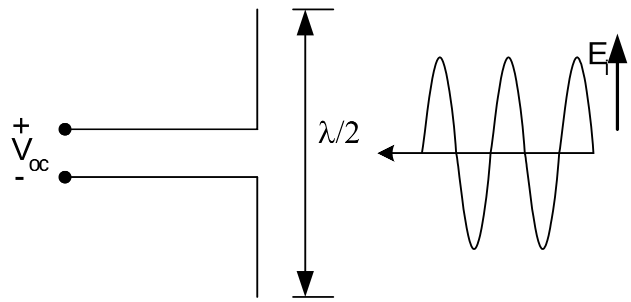
$E_\theta =$

$H_\phi =$

c: Determine the time average power density in the far zone?

Problem 4:

A plane wave describe by E-field $\mathbf{E}_i$ is normally incident upon an open circuits $\lambda/2$ dipole. You are required to find the maximum effective area A_e of the $\lambda/2$ dipole antenna shown below (assume the dipole in free space):



Determine the following:

A) V_{oc} =

B) Incident power density

C) Maxiumum A_e