THE UNIVERSITY OF TEXAS AT DALLAS

Electromagnetic Engineering I

EE 4301

Spring 2008
Assignment 1

Due Date:

January 14, 2008

Reading:

N. N. Rao, *Elements of Engineering Electromagnetics*, **Sixth Edition**, Chapter 1

Reference and Review Activities:

Take Dr. Carol Crawford's tutorial on complex numbers, U.S. Naval Academy

Learn the Greek alphabet

Watch Professor Walter Lewin, Physics 2, MIT, Lecture 1

Study Professor Syed A. Nasar, *2008+ Solved Problems in Electromagnetics*, Chapter 1

Problems:

Please write your answers to the following problems on engineering paper. No credit will be given for work handed in on other types of paper.

1. Plot the following numbers in the complex plane. For each number,

$$z = x + jy = re^{j\theta} = r\angle\theta,$$

give the numerical values of the real part (x), the imaginary part (y), the modulus (r), and the phase angle in radians (θ, where $0 \leq \theta < 2\pi$):

(a) $\frac{1}{2} - j\frac{1}{2}\sqrt{3}$
(b) $1 + j$
(c) $(\frac{1}{2} - j\frac{1}{2}\sqrt{3})^2$
(d) $(1 + j)^2$
(e) $(\frac{1}{2} + j\frac{1}{2}\sqrt{3})^{-1}$
(f) $(\frac{1}{2} - j\frac{1}{2}\sqrt{3})^6$

2. Find and plot the complex conjugate of each of the complex numbers in Problem 1.

3. State Euler's theorem, and use it to evaluate the real and imaginary parts of $e^{j\pi/4}$ without using a calculator.

4. Express each of the following complex numbers in rectangular form, $x + jy$:

   (a) $e^{-j\pi/6}$ (reduce your answer to numerical form; don't leave it in terms of trigonometric functions)

   (b) $7e^{4j\pi/3}$ (reduce your answer to numerical form; don't leave it in terms of trigonometric functions)

5. A capcitor has a capacitance $C = 1.57$ pF. Find the magnitude of the capacitive reactance, X_C, at the frequency $f = 100$ MHz. Figure out and explain how to solve this problem without using a calculator.

6. You are given the following impedances:

$$Z_1 = 2 + j3\ \Omega, \qquad Z_2 = 1 - j5\ \Omega.$$

   (a) Find the impedance of Z_1 and Z_2 in series, in rectangular form $(x + jy)$.

   (b) Find the impedance of Z_1 and Z_2 in series, in polar form $(re^{j\theta})$.

   (c) Find the impedance of Z_1 and Z_2 in parallel, in rectangular form $(x + jy)$.

   (d) Find the impedance of Z_1 and Z_2 in parallel, in polar form $(re^{j\theta})$.

7. Find

$$\frac{d}{dt}\, e^{j\omega t} \quad \text{and} \quad \int e^{j\omega t} dt$$

8. Find the vector cross product $\mathbf{A} \times \mathbf{B}$, where

$$\mathbf{A} = 7\hat{\mathbf{x}} - \hat{\mathbf{y}} + 4\hat{\mathbf{z}}, \qquad \mathbf{B} = 3\hat{\mathbf{x}} - 2\hat{\mathbf{y}} + 5\hat{\mathbf{z}}.$$

9. Find the gradient of the scalar field

$$\Phi(x, y, z) = e^x \sinh(y^2) \cos(z^3)$$

   in Cartesian coordinates.

10. Find the divergence of the vector field

$$\mathbf{F}(x, y, z) = \cos(xy^2z^3)\hat{\mathbf{x}} + e^{xyz}\hat{\mathbf{y}} + \left(\int^z z^{-1} dz \right) \hat{\mathbf{z}}$$

    in Cartesian coordinates.