GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL of ELECTRICAL and COMPUTER ENGINEERING

EE 2200 Fall 1998
Problem Set #0

Assigned: 25 Sept 1998
Due Date: 31 Sept 1998 (NEVER)

Reading: In *DSP First*, Appendix A on *Complex Numbers*, pages 378–398.

The web site for the course uses Web-CT:

`http://webct.ece.gatech.edu`

Your initial password is digits 4 through 8 of your SSN.

None of these problems will have to be turned in for grading.

Some of the problems have solutions that can be found on the CD-ROM. Next week a solution will be posted to the web.

Several different mathematical notations can be used to represent complex numbers. In *rectangular form* we will use all of the following notations:

$$\begin{aligned} z &= (x, y) \\ &= x + jy \qquad\qquad \text{where } j = \sqrt{-1} \\ &= \Re e\{z\} + j\Im m\{z\} \end{aligned}$$

The pair (x, y) can be drawn as a vector, such that x is the horizontal coordinate and y the vertical coordinate.

In *polar form* we will use these notations:

$$\begin{aligned} z &= |z|e^{j \arg z} \\ &= re^{j\theta} \\ &= r\angle\theta \end{aligned}$$

where $|z| = r = \sqrt{x^2 + y^2}$ and $\arg z = \theta = \arctan(y/x)$. Again, in a vector drawing, r is the length and θ the direction of the vector.

Euler's Formula:

$$re^{j\theta} = r\cos\theta + jr\sin\theta$$

can be used to convert between Cartesian and polar forms.

In these review problems you will manipulate some complex numbers. A calculator will be useful for this purpose, especially if it is one with complex arithmetic capability. It is convenient to learn how to use this feature. However, it is also worthwhile to be able to do the calculations by hand; i.e., it is important to *understand* what your calculator is doing!

PROBLEM 0.1:

Convert the following to polar form:

(a) $z = 0 - j3$
(b) $z = 3 - j4$
(c) $z = (1, -1)$
(d) $z = (0, 4)$

Give numerical values for the magnitude and angle (phase).

PROBLEM 0.2:

Convert the following to rectangular form:

(a) $z = \sqrt{2}\, e^{-j(3\pi/4)}$
(b) $z = 7e^{j(3\pi/2)}$
(c) $z = 1.6 \angle (\pi/3)$
(d) $z = 3 \angle (11\pi)$

Give numerical values for the real and imaginary parts.

PROBLEM 0.3:

Evaluate the following and give the answer in both rectangular and polar form. In all cases, assume that the complex numbers are $z_1 = -4 + j2$ and $z_2 = -1 - j$.

(a) Conjugate: z_1^*
(b) jz_2
(c) z_2/z_1
(d) z_2^2
(e) $z_1^{-1} = 1/z_1$
(f) $z_1 z_1^*$
(g) $z_1 + z_2^*$
(h) z_1/z_2
(i) $z_1 z_2$

Note: z^* means the "conjugate" of z.

PROBLEM 0.4:

Simplify the following complex-valued expressions:

(a) $(\sqrt{3} - j)^4$

(b) $(\sqrt{3} - j)^{-1}$

(c) $4e^{-j\pi/3} + 3e^{j\pi/6}$

Give the answers in *both* Cartesian $(x + jy)$ and polar form $(re^{j\theta})$.

PROBLEM 0.5:

Use Euler's formula to evaluate j^j