EECS 210 Fall 00
Homework #9
Due(in class) Friday 11/10/00

(Note: The numbered problems are from chapter 9 of your textbook . In problems 2-4 use the values of z_1, z_2 and z_3 given in problem 1.)

Read sections 9.12, 10.1, 10.2 and 10.6 in your textbook.

1. Convert the following complex numbers from cartesian form to complex exponential form. Also plot the complex numbers in the cartesian plane

(a) $z_1=1 + 2j$
(b) $z_2=2+ 3j$
(c) $z_3=1 – j$

2. Evaluate the product $z_1\ z_2\ z_3$ and express your answer in both cartesian and complex exponential form by

(a) Performing the multiplication entirely in cartesian coordinates.
(b) Performing the multiplication entirely using the complex exponential form.

3. Evaluate the quotient $z_1/\ z_2$ and express your answer in both cartesian and complex exponential form by

(a) Performing the division by first converting z_1 and z_2 to complex exponential form.
(b) Performing the division working entirely in cartesian coordinates by first multiplying the numerator and denominator of $z_1/\ z_2$ by $(z_2)^*$.

4. Find the modulus of the quotient $z_1/\ z_2$ by

(a) Using your result in problem 3(b).
(b) Finding the moduli of the numerator and denominator separately and dividing them.

5. 9.6(d)

6. 9.22

7. 9.23

8. 9.29

9. 9.25

10. 9.14

11. 9.21

12. (Lab Problem form Alex Ganago). There is no need to hand this problem in.

Students build electronic thermometers using thermocouples (p. 77-78 of Laboratory Manual) and differential amplifiers (p. 73 of Laboratory Manual). They also learn that the op amps are not ideal: each chip may have an input offset voltage V_{os} (p. 56, 66-67), which may cause uncertainty in the temperature readings.

Determine the error in temperature measurements due to V_{os} assuming that students use LM 747 op amps that have parameters matching those of LM 741, including typical (not maximal) values of V_{os}.

Discuss for which of the following applications the thermometers are satisfactory:

(a) monitoring the body temperature of a patient during surgery (maximal error ± 0.05 °C)
(b) monitoring outdoor temperature (max error ± 0.5 °C)
(c) monitoring the temperature in a kitchen oven (max error ± 5 °C).

Suppose that students improve their circuits by using 20 kOhm potentiometers (p. 75 of Laboratory Manual) and reduced the effects of V_{os} by a factor of 100.

What is the uncertainty of the temperature readings after this improvement?

Discuss the usefulness of improved thermometers for the applications listed above.