

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
Department of Electrical and Computer Engineering
ECE 498DJ PRINCIPLES OF SIGNAL ANALYSIS

Problem Set 1
Fall 2011

Assigned: 8/26/2011

Due: 9/2/2011

Problem 1.1

Express the following complex numbers in both standard cartesian form $z = x + jy$ and polar form $z = re^{j\theta}$ (do this by hand for the practice, but you're encouraged to check your answers with a calculator or in Matlab!)

- (a) $(1 + j2) - (2 + 3j)$
- (b) $(1 + j)(2j)$
- (c) $(1 - j)(2 + 2j)$
- (d) $(1 - j)/(2 + 2j)$
- (e) $e^{j\frac{\pi}{2}} + e^{j\pi} + e^{j\frac{3\pi}{2}} - j$
- (f) $j \exp(j\pi/4)$
- (g) $\frac{e^{j\frac{\pi}{4}}}{j}$

Problem 1.2

Simplify the following signal in complex exponential form to the corresponding real-valued signal:

$$x(t) = e^{j\pi/3}e^{-j\pi t/10} + e^{-j\pi/3}e^{j\pi t/10} + je^{j\pi(t-5)/2} - je^{-j\pi(t-5)/2}$$

Problem 1.3

Write the following signal in complex exponential form: $x(t) = \cos\left(\frac{\pi t}{7}\right) + \sin\left(\frac{\pi t}{7}\right)$

Problem 1.4

Calculate the Fourier series coefficients $a_0, a_k, b_k, k = 1, 2, \dots$, for the periodic signal $x(t) = x(t + 8)$:

$$x(t) = \begin{cases} 0, & 0 \leq t < 1 \\ 1, & 1 \leq t \leq 3 \\ 0, & 3 < t < 5 \\ -1, & 5 \leq t \leq 7 \\ 0, & 7 < t \leq 8 \end{cases}$$

Problem 1.5

Calculate the complex exponential Fourier series coefficients, X_k , $-\infty < k < \infty$, for the above signal.

Problem 1.6

Sketch the signal $x(t) = 1 + \cos(\pi t/2) + \sin(\pi t)$ over at least the interval $0 \leq t \leq 8$ seconds. What is the period T_0 of $x(t)$? What are the Fourier series coefficients a_0 , a_k , b_k , $k = 1, 2, \dots$, of this periodic signal?