UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
Department of Electrical and Computer Engineering

ECE 310 Digital Signal Processing – Fall 2023

Homework 1

Profs. Do, Moustakides, Snyder **Due: September 1, 2023 on Gradescope**

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1. Evaluate and represent your final answer in both Cartesian and polar forms for each of the following complex expressions.
   (a) $2e^{j\pi/3} + e^{-j\pi/2}$
   (b) $\frac{1+j}{1-j2}$

2. Determine all roots of $16z^3 + 2 = 0$ on the complex plane.

3. Determine the magnitude and phase (in radians) of each of the following complex expressions and sketch each on the complex plane.
   (a) -2
   (b) $-j3$
   (c) $-3 - j4$
   (d) $1 - e^{j\pi/4}$

4. Sketch the following signals:
   (a) $\sin^2\left(\frac{\pi}{8}n\right)\delta[n-2]$
   (b) $n(u[n-2] - u[n-6])$
   (c) $u[-n+3]u[n+1]$
   (d) $2^n \sum_{k=0}^{2} \delta[n-2k]$

5. Consider the sequence $x[n] = \{\cdots, 0, 2, \underset{\uparrow}{0}, -1, 1, 3, 0, \cdots\}$ where $\underset{\uparrow}{\cdot}$ denotes the $n = 0$ sample and $\cdots$ denotes all zeros.
   (a) Express $x[n]$ in terms of scaled and shifted versions of the unit impulse signal $\delta[n]$.
   (b) Sketch $y[n] = x[2n-1]$.
   (c) Sketch $v[n] = 2x[4-n]$.

6. For each of the following discrete-time systems, determine if the system is 1) linear, 2) time-invariant, 3) causal.
   (a) $y[n] = 3x[n] - x[n-1]$
   (b) $y[n] = x[n+2] + 2$
   (c) $y[n] = (n+1)x[n-1]$
   (d) $y[n] = |x[n^4]|$