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

ECE 498MH Principles of Signal Analysis
Fall 2014

MIDTERM EXAM

Friday, October 3, 2014

- This is a CLOSED BOOK exam.
- There are a total of 100 points in the exam. Each problem specifies its point total. Plan your work accordingly.
- You must SHOW YOUR WORK to get full credit.

Problem	Score
1	
2	
3	
4	
Total	

Name: _____

Problem 1 (25 points)

Each of the following is sampled at $F_s = 10000$ samples/second, producing either $x[n]$ =constant, or $x[n] = \cos \omega n$ for some value of ω. Specify the constant if possible; otherwise, specify ω such that $-\pi \leq \omega < \pi$.

(a) $x(t) = \cos(2\pi 900t)$

(b) $x(t) = \cos(2\pi 10000t)$

(c) $x(t) = \cos(2\pi 11000t)$

Problem 2 (25 points)

Consider the signal

$$x(t) = 2\cos(2\pi 440t) - 3\sin(2\pi 440t)$$

This signal can also be written as $x(t) = A\cos(\omega t + \theta)$ for some $A = \sqrt{M}$, ω, and $\theta = \text{atan}(R)$. Find M, ω, and R.

Problem 3 (25 points)

A signal $x(t)$ is periodic with $T_0 = 0.02$ seconds, and its values are specified by

$$x(t) = \begin{cases} -1 & 0 \leq t \leq 0.01 \\ 0 & 0.01 < t < 0.02 \end{cases}$$

Its CTFS representation is defined by

$$x(t) = \sum_{k=-\infty}^{\infty} X_k e^{jk\omega_0 t}$$

(a) Sketch $x(t)$ as a function of t for $0 \leq t \leq 0.02$ seconds. Label at least one important tic mark, each, on the horizontal and vertical axes.

(b) What is ω_0?

(c) Find X_0 without doing any integral.

PROBLEM 3 CONTINUED

(d) Find X_k for all the other values of k, i.e., for $k \neq 0$. Simplify; your answer should have no exponentials in it.

Problem 4 (25 points)

Consider the signal

$$x[n] = \begin{cases} \left(\frac{1}{2}\right)^n & n \geq 0 \\ 0 & n < 0 \end{cases}$$

(a) Find the DTFT, $X(\omega)$.

PROBLEM 4 CONTINUED

(b) Find the power spectrum $|X(\omega)|^2$, and sketch it for $-\pi \leq \omega \leq \pi$. Specify its values at $\omega = 0$, $\omega = \frac{\pi}{2}$, and $\omega = \pi$.