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

ECE 498MH Principles of Signal Analysis
Fall 2013

MIDTERM EXAM

Wednesday, October 1, 2013

- 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	
5	
Total	

Name: _____

θ	$\cos\theta$	$\sin\theta$	$e^{j\theta}$
0	1	0	1
$\pi/6$	$\sqrt{3}/2$	$1/2$	$\sqrt{3}/2 + j/2$
$\pi/4$	$\sqrt{2}/2$	$\sqrt{2}/2$	$\sqrt{2}/2 + j\sqrt{2}/2$
$\pi/3$	$1/2$	$\sqrt{3}/2$	$1/2 + j\sqrt{3}/2$
$\pi/2$	0	1	j
π	-1	0	-1
$3\pi/2$	1	-1	$-j$
2π	1	0	1

Problem 1 (20 points)

$$\cos(\omega t) + \cos(\omega t + \frac{\pi}{3}) = m\cos(\omega t + \theta)$$

Find x and y such that $m = \sqrt{x^2 + y^2}$ and $\theta = \text{atan2}(x, y)$, the two-argument arctangent of x and y.

Problem 2 (20 points)

A signal $x(t) = \cos(2\pi 6000t)$ is sampled at $F_s = 8000$ samples/second to create $y[n]$. The digital signal $y[n]$ is then played back through an ideal D/A at the same sampling rate, $F_s = 8000$ samples/second, to generate a signal $z(t)$. Find $z(t)$.

Problem 3 (20 points)

The signal $x[n]$ is periodic with period $N_0 = 4$. Its values in each period are

$$x[n] = \begin{cases} 1 & n = 0 \\ -1 & n = 1, 2, 3 \end{cases}$$

Find the Fourier series coefficients.

Problem 4 (20 points)

The system called "modulation" has the following relationship between its input $x[n]$ and its output $y[n]$:

$$y[n] = x[n]\cos(\omega_0 n)$$

Prove that this is a time-varying system.

Problem 5 (20 points)

Find $y[n] = x[n] * h[n]$, where $x[n]$ and $h[n]$ are given as

$$x[n] = \begin{cases} 1 & 0 \leq n \leq 9 \\ 0 & \text{otherwise} \end{cases}$$

$$h[n] = \begin{cases} 1 & n = 0 \\ -1 & n = 1 \\ 0 & \text{otherwise} \end{cases}$$