EE461 Midterm:

NAME

STUDENT NO

Date: Monday, October 20, 2010
Time = 1.5 hours
One 8.5 by 11 formula sheet (writing both sides)
(i.e. no Text Books or Notes)
Absolutely no worked examples or solved problems

NB: Draw a box around your final answer.

1.	4	(4)
2.	4	(4)
3.	6	(6)
4.	6	(6)
5.	8	(12)
6.	4	(4)
TOTAL	32	(36)

ω = rad/samp ∘ n

1. Consider a system that has a real impulse response and a frequency response specified by

$$H(e^{j\omega}) = \omega^2 + j\omega; \quad 0 < \omega < \pi,$$

$\frac{26.57^\circ}{360^\circ} \cdot 2\pi = 0.464$ rads

(2) (a) Find $H(e^{-j})$.

(2) (b) Find the steady state output (call it $y[n]$) if the input to the system is

$$x[n] = \cos(n) + 2\sin(2n+1).$$

$\omega = -1$ $\omega = 1$ $\omega = 2$

a) $-1^2 + j(-1)$

$H(e^{j}) = \boxed{1 + j}$

B) $H(e^{j1}) = 1 + j1 = 1.41 \angle 45^\circ$

$H(e^{j2}) = 4 + j2 = 4.47 \angle 26.57^\circ$

$y[n] = |H(e^{j\omega})| \cdot |x[n]| \angle \angle x[n] + \angle H(e^{j\omega})$

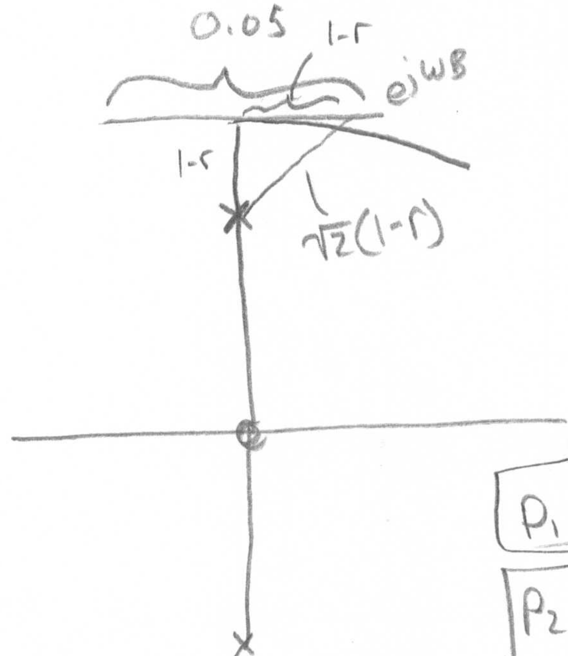
$y[n] = 1.41 \cos(n + \pi/4) + 8.94 \sin(2n + 1 + 0.464)$

$\boxed{y[n] = 1.41 \cos(n + \pi/4) + 8.94 \sin(2n + 1.464)}$

(4) 2. Approximately where would the poles have to be placed in a two pole band-pass filter to produce a filter with a bandwidth of 0.05 radians per sample at a center frequency of $\pi/2$ radians per sample?

2 pole BPF $\quad BW = 0.05$ rad/samp $\quad f_0 = \pi/2$

@ angle $\pi/2$



$2(1-r) = 0.05$

$r = 0.975$

$\boxed{P_1 = 0.975\, e^{j\pi/2}}$

$\boxed{P_2 = 0.975\, e^{-j\pi/2}}$

$|e^{j\omega b} - r|$

3. A random sequence with correlation between successive samples is generated by flipping a coin and filtering. The input to the filter, say $x(n)$, is generated by flipping a coin for every sample. If the coin shows 'head' on the n^{th} toss, then $x(n) = 1$, if the coin shows 'tail' $x(n) = -1$. x(n) is filtered with a single zero filter to get sequence $y(n)$. The zero is located at $z = -1$ and coefficient $b_0 = 1$. The output of the filter is given by

$$y(n) = \sum_{k=0}^{1} x(n-k)h(k), \quad \text{where } h(n) \text{ is the impulse response.}$$

(2) (a) What are $\overline{x(n)}$ and $\overline{x^2(n)}$?

(2) (b) Find $h(n)$.

(1) (c) What possible values can $y(n)$ take on?

(1) (d) Is it possible for one sample to have a value of +2 and the next to have a value of -2?

prob

h 1 ½

t -1 ½

$H(z) = \frac{(z+1)}{z}$

$\boxed{\overline{x^2(n)} = 1 \quad \overline{x(n)} = \cancel{1}}$

a) $\mu = 1 \cdot \frac{1}{2} + -1 \cdot \frac{1}{2} = 0$

total Ave power $= 1^2(\frac{1}{2}) + (-1)^2(\frac{1}{2}) = 1$

rms $= \sqrt{\text{AC power}} = \sqrt{1} = 1$

Ave AC power $= 1 - 0 = 1$

B) $H(z) = (1 + z^{-1})$

$H(z) = \sum_{n=-\infty}^{\infty} h[n] z^{-n}$

$\boxed{h[n] = \delta[n] + \delta[n-1]}$

$n=0$

$h[0] = 1$

$n=1$

$h[1] = 1$

c) since $h[n] = y[n]$ if $x[n] = \delta[n]$

$y[n] = x[n] + x[n-1]$

$\boxed{y = 2, 0, \pm 2}$

output comb

1 1	-1 -1
1 -1	
-1 1	

to get +2: $x[n]=1$ $x[n-1]=1$

to get -2: $x[n]=-1$ $x[n-1]=-1$

d) $\boxed{\text{no}}$ Can not change both $x[n]$ & $x[n-1]$ in one step