Name: Key

Section: _____

EE322 Fall 2010 Exam 1: Part 1

Problem		Possible Points	Score
Part 1	1	25	
	2	25	
	3	25	
	4	25	
Part 2	5	10	
	6	20	
Total		130	

- You will have the first 60 minutes of the lab period to take Part 1 of the exam.
- For this portion of the exam, you are allowed to use 1 page, single-side of notes or whatever you want to write on it, and an FE Exam-approved calculator.

  Indicate the manufacturer and model of the calculator you will use for this exam:

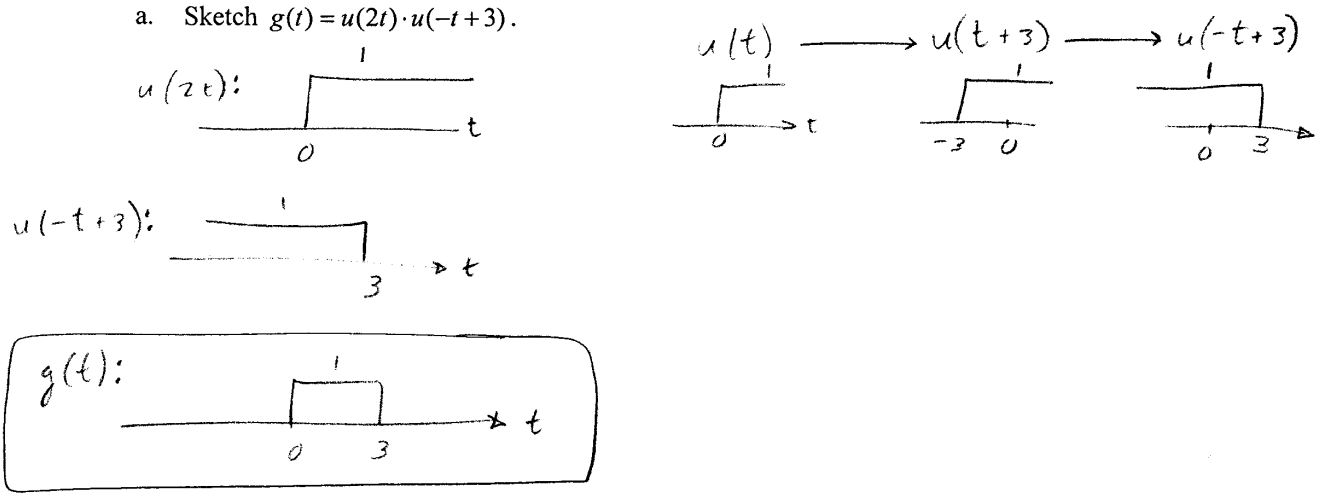
  Calculator: _____

- You ***must show your work*** to get full credit for problems. Expect to lose points if you don't.
- Label your sketches (axes and functions) carefully, including units if applicable. Expect to lose points if you don't.
- If you finish Part 1 of the exam before it is called for, turn it in and pick up Part 2 (MATLAB).
- Sign the statement below:

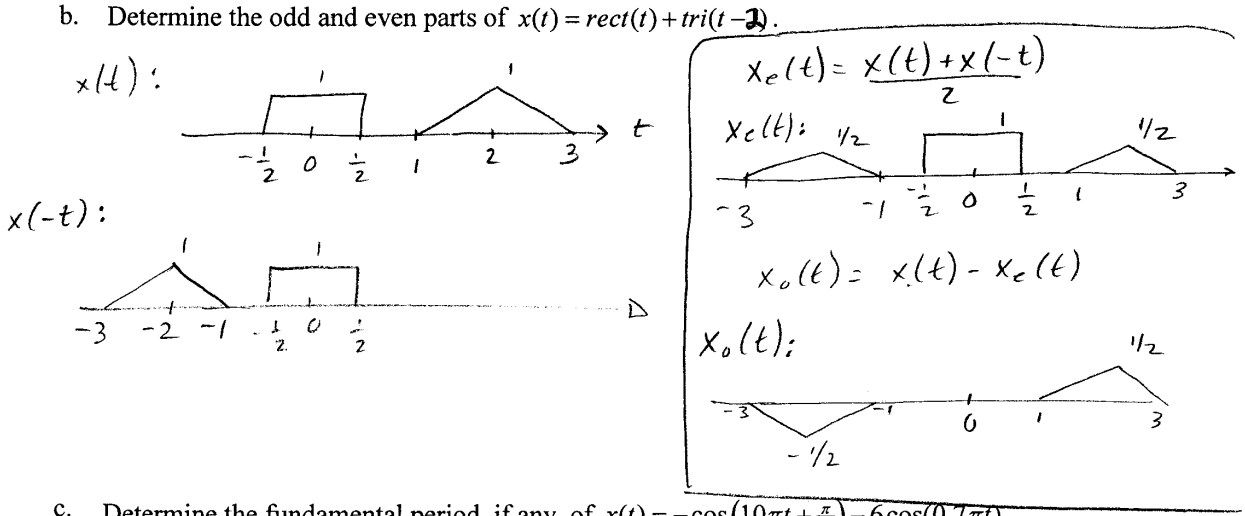
will not discuss this exam with anyone until after 6th period today. _____
(Signature)

1. (25 pts) Continuous-time.

a. Sketch $g(t) = u(2t) \cdot u(-t+3)$.



b. Determine the odd and even parts of $x(t) = rect(t) + tri(t-1)$.



c. Determine the fundamental period, if any, of $x(t) = -\cos\left(10\pi t + \frac{\pi}{15}\right) - 6\cos(0.7\pi t)$

$-\cos(2\pi 5 t) - 6\cos\left(2\pi \frac{7}{20} t\right)$

$f_1 = 5$, $T_1 = 1/5$

$f_2 = \frac{7}{20}$, $T_2 = \frac{20}{7}$

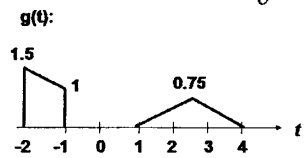
$T_0 = LCM\left(\frac{1}{5}, \frac{20}{7}\right)$

$= \frac{LCM\left(\frac{35}{5}, \frac{700}{7}\right)}{35} = \frac{LCM(7, 100)}{35}$

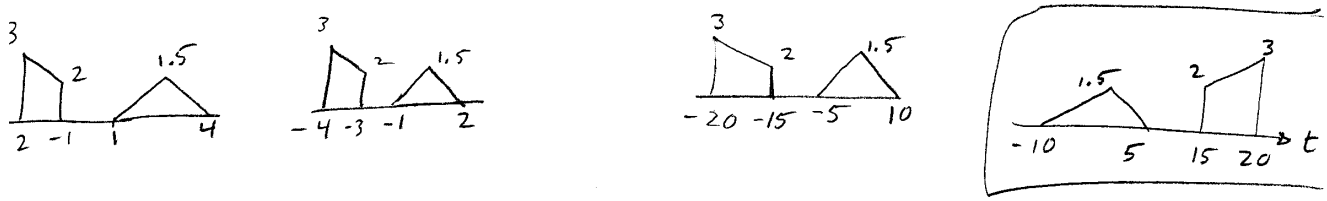
$= \frac{700}{35} = \boxed{20 \text{ sec}}$

2. (25 pts) Continuous-time.

a. Given the signal below, sketch $2g(-0.2t+2)$. $= 2g\left(-\frac{t}{5}+2\right)$



$$2g(t) \xrightarrow[t \to t+2]{} 2g(t+2) \xrightarrow[t \to t/5]{} 2g\left(\frac{t}{5}+2\right) \xrightarrow[t \to -t]{} 2g\left(-\frac{t}{5}+2\right)$$

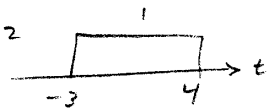


b. Calculate the energy (if an energy signal) or power (if a power signal) associated with the following:

(1) $y(t) = u(t+3) - u(t-4)$

$y(t)$

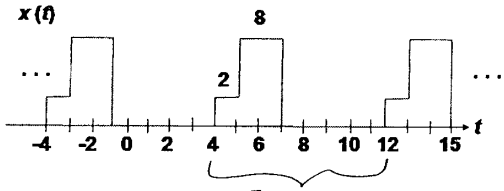
$|y(t)|^2$



$$E_y = \int_{-\infty}^{\infty} |y(t)|^2 dt$$

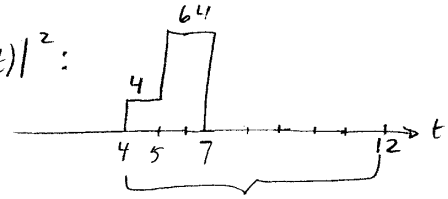
$$= \int_{-3}^{4} 1\, dt = \boxed{7}$$

(2)



Periodic, $T_0 = 8$

1 period of $|x(t)|^2$:



$$P_x = \frac{1}{T_0} \int_{1\,\text{period}} |x(t)|^2 dt$$

$$= \frac{1}{8}\left(4(1) + 64(2)\right)$$

$$= \frac{132}{8} = \boxed{16.5}$$

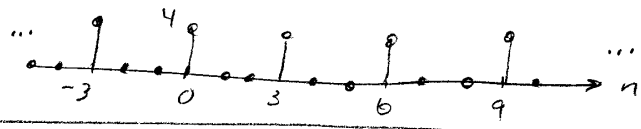
3. (25 pts) Discrete-time.

Suppose you are given the following discrete-time function:

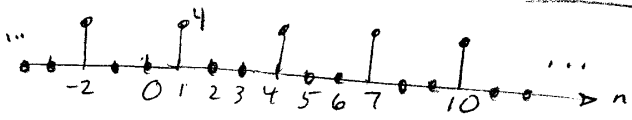
$$x[n] = 4\delta_3[n-4].$$

a. Sketch x[n].

$4\delta_3[n]$:



$x[n] = 4\delta_3[n-4]$



b. What is the energy in this signal? The average power? Is this an energy signal or a power signal? Why?

$N_0 = 3$

$$E_x = \sum_{n=-\infty}^{\infty} |x[n]|^2 = \boxed{\infty}$$

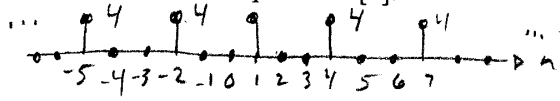
$$P_x = \frac{1}{3} \sum_{1\,\text{period}} |x[n]|^2 = \boxed{\frac{16}{3}}$$

power signal

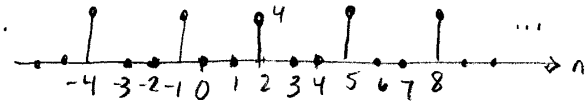
(finite avg pwr, infinite Energy)

c. Sketch the even and odd parts of x[n].

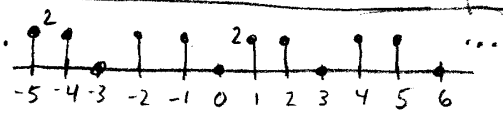
$x[n]$



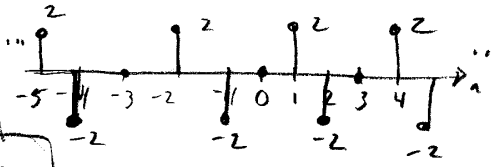
$x[-n]$



$x_e[n] = \dfrac{x[n] + x[-n]}{2}$

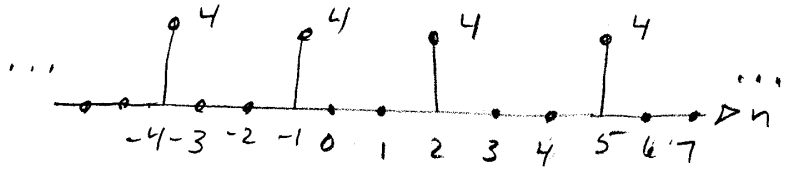


$x_o[n] = x[n] - x_e[n]$



d. Sketch $y[n] = x[2n]$. time compression by a factor of 2

more room



n	$y[n] = x[2n]$
-2	$y[-2] = x[-4] = 0$
-1	$y[-1] = x[-2] = 4$
0	$y[0] = x[0] = 0$
1	$y[1] = x[2] = 0$
2	$y[2] = x[4] = 4$
3	$y[3] = x[6] = 0$
⋮	

4. (25 pts) Discrete time. Given the system described by

$$y[n] = \ln(|x[n-1]|) \quad \text{(note: ln} \equiv \text{natural log function)}.$$

Note: this is NOT the x[n] from problem 3.

a. Is the system BIBO stable? Show why it is or isn't.

No - if $x[n] = 0$ (the zero function), then

$$|y[n]| = \ln(|x[n-1]|) = \ln(0) = \infty$$

a bounded input produces an unbounded output.

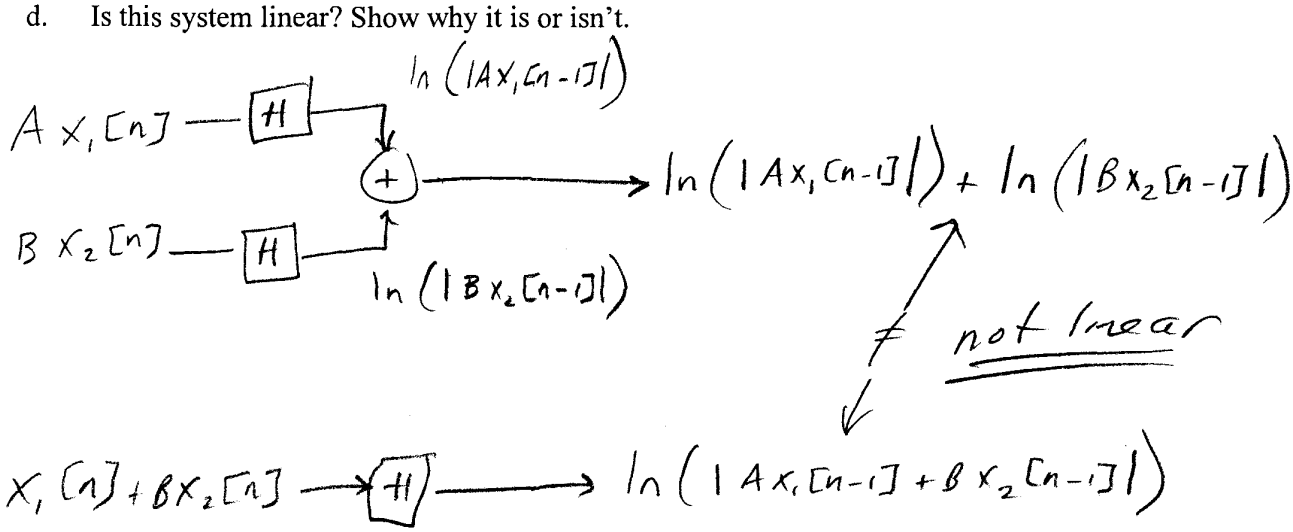
b. Is the system causal? Why or why not?

yes for any time n_0, the output at time n_0 depends only on a past value of the input, $x[n_0-1]$

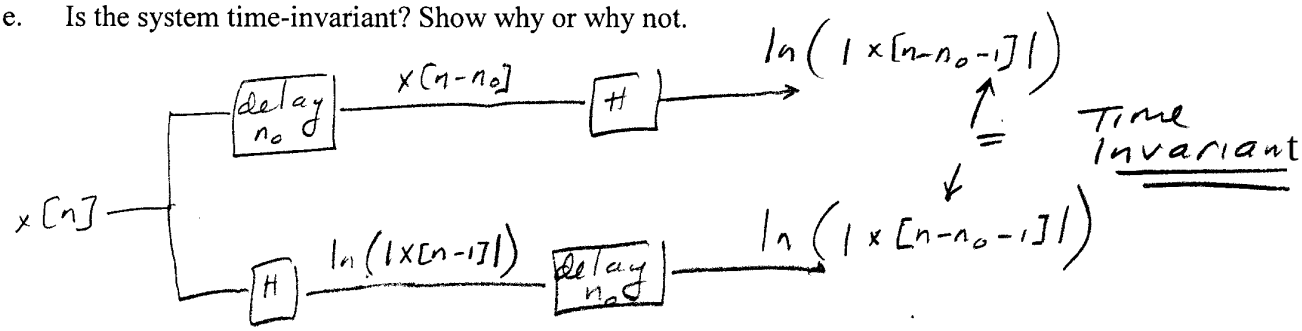
c. Is the system memoryless? Why or why not?

No since the system output at any time depends on a past input, not solely on the current input.

d. Is this system linear? Show why it is or isn't.



e. Is the system time-invariant? Show why or why not.



f. Is the system invertible? Show why or why not.

No because of the absolute value, the unique input-output value relationship does not exist.

For example

if $x[n-1] = +1$ or -1, $y[n] = \ln(|1|) = 0$

so two different input values yield the same output value.