The University of Texas at Austin
Dept. of Electrical and Computer Engineering
Midterm #1

Date: February 25, 2009 Course: EE 313 Evans

Name: _____
Last, First

- The exam is scheduled to last 50 minutes.
- Open books and open notes. You may refer to your homework assignments and homework solution sets.
- **Power off all cell phones and pagers**
- You may use any standalone calculator or other computing system, i.e. one that is not connected to a network.
- All work should be performed on the quiz itself. If more space is needed, then use the backs of the pages.
- **Fully justify your answers unless instructed otherwise.**

Problem	Point Value	Your score	Topic
1	30		Differential Equation
2	25		Convolution
3	30		Tapped Delay Line
4	15		Potpourri
Total	100		

Problem 1.1 Differential Equation. *30 points*.

For a continuous-time system with input $x(t)$ and output $y(t)$ governed by the differential equation

$$\frac{d^2}{dt^2}y(t) + 8\frac{d}{dt}y(t) + 15y(t) = x(t)$$

for $t \geq 0^+$.

(a) What are the characteristic roots of the differential equation? *5 points*.

(b) Find the zero-input response assuming non-zero initial conditions. Please leave your answer in terms of C_1 and C_2. *10 points*.

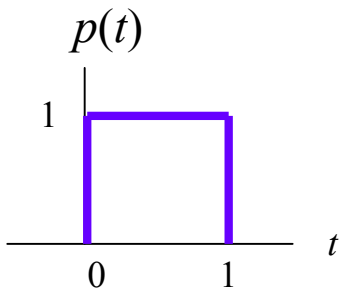
(c) Find the zero-input response for the following initial conditions: $y(0^+) = 0$ and $y'(0^+) = -2$. *10 points*.

(d) Is the zero-input response asymptotically stable, marginally stable, or unstable? Why? *5 points*.

Problem 1.2 Convolution. *25 points*.

Let $p(t)$ be a causal rectangular pulse:

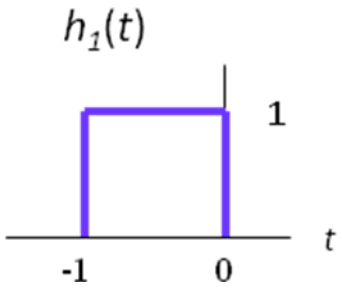
$$p(t) = \begin{cases} 1 & \text{for } 0 \le t \le 1 \\ 0 & \text{otherwise} \end{cases}$$



Sketch (plot) the following convolutions. On the sketches, be sure to label significant points on the horizontal and vertical axes. You do not have to show intermediate work, but showing intermediate work may qualify for partial credit.

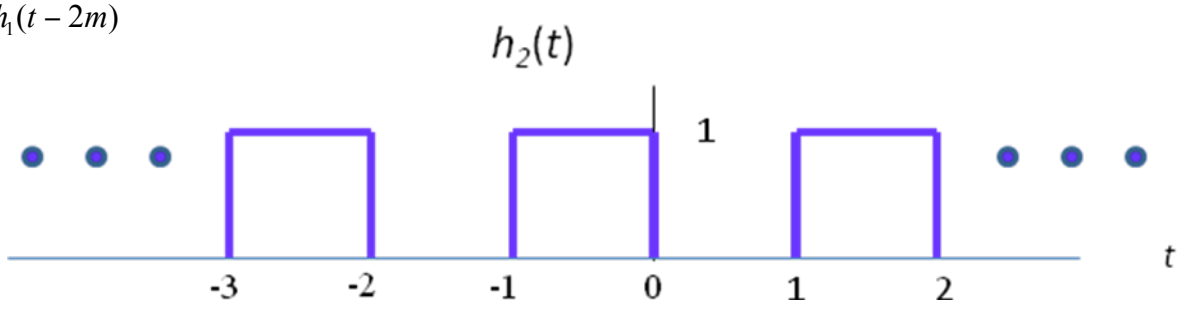
(a) Convolve $p(t)$ with $h_1(t)$ where (*10 points*)

$$h_1(t) = \begin{cases} 1 & \text{for } -1 \le t \le 0 \\ 0 & \text{otherwise} \end{cases}$$



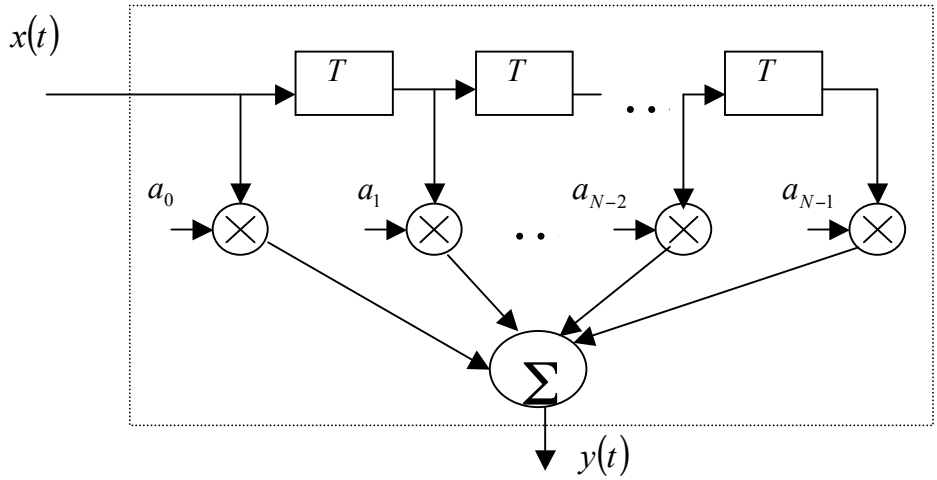
(b) Convolve $p(t)$ with $h_2(t)$ where (*15 points*)

$$h_2(t) = \sum_{m=-\infty}^{\infty} h_1(t - 2m)$$



Problem 1.3 Tapped Delay Line. *30 points*.

A linear time-invariant (LTI) continuous-time tapped delay line with input $x(t)$, output $y(t)$, and N-1 delay elements is shown below as a block diagram (from slide 2-4):



(a) What are the initial conditions? To what value(s) should they be set? *10 points*.

(b) Give a formula for the impulse response $h(t)$. *5 points*.

(c) Is the LTI continuous-time tapped delay line always bounded-input bounded-output (BIBO) stable? Why or why not? *15 points*.

Problem 1.4 Potpourri. *15 points*.

(a) Give an example of a discrete-time analog signal. Please plot your example. *5 points*.

(b) Give an example of a continuous-time digital signal. Please plot your example. *5 points*.

(c) *Either prove the following statement to be true, or give a counterexample to show that the following statement is false*: If a system contains a nonlinear subsystem, then the system is always a nonlinear system. *5 points*. *Please note that writing only true or false will receive zero points.*