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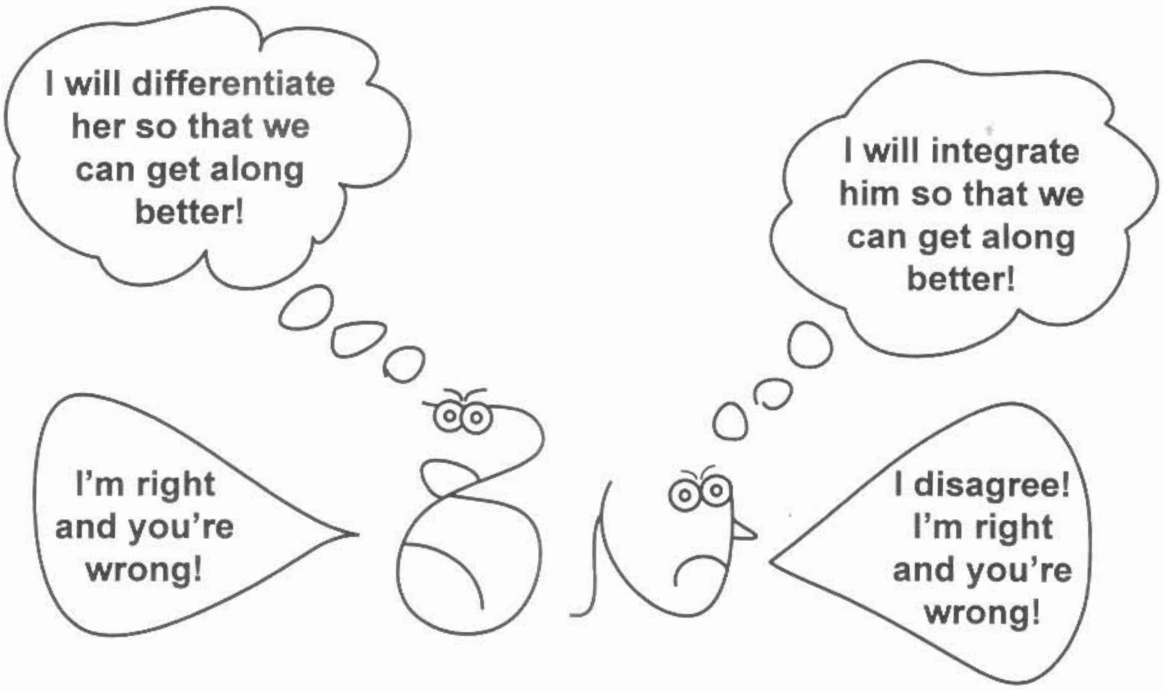

University of Portland
School of Engineering

EE 262-δignals & δystems-3 cr. hrs.
Spring 2006
SOLUTIONS TO
Midterm Exam # 1
(Prepared by Professor A. S. Inan)

(Monday, February 27, 2006)
(Closed Book Exam, One formula sheet is allowed.)
(Total Time: 55 mins.)

Name: SOLUTIONS! ☺

Signature: ☺

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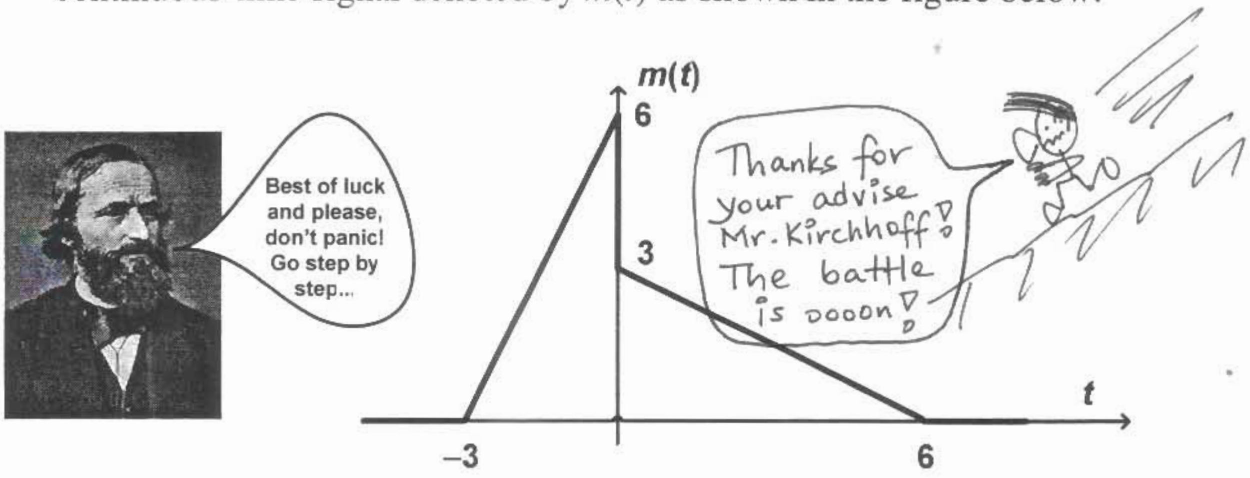
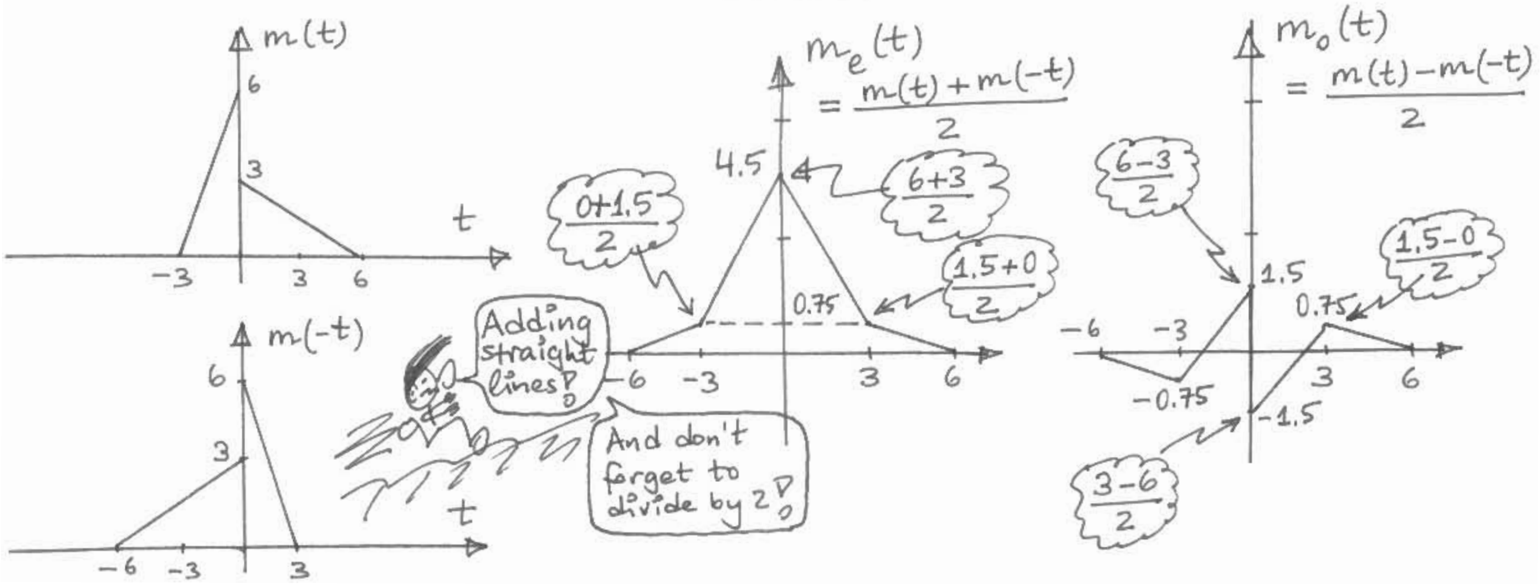
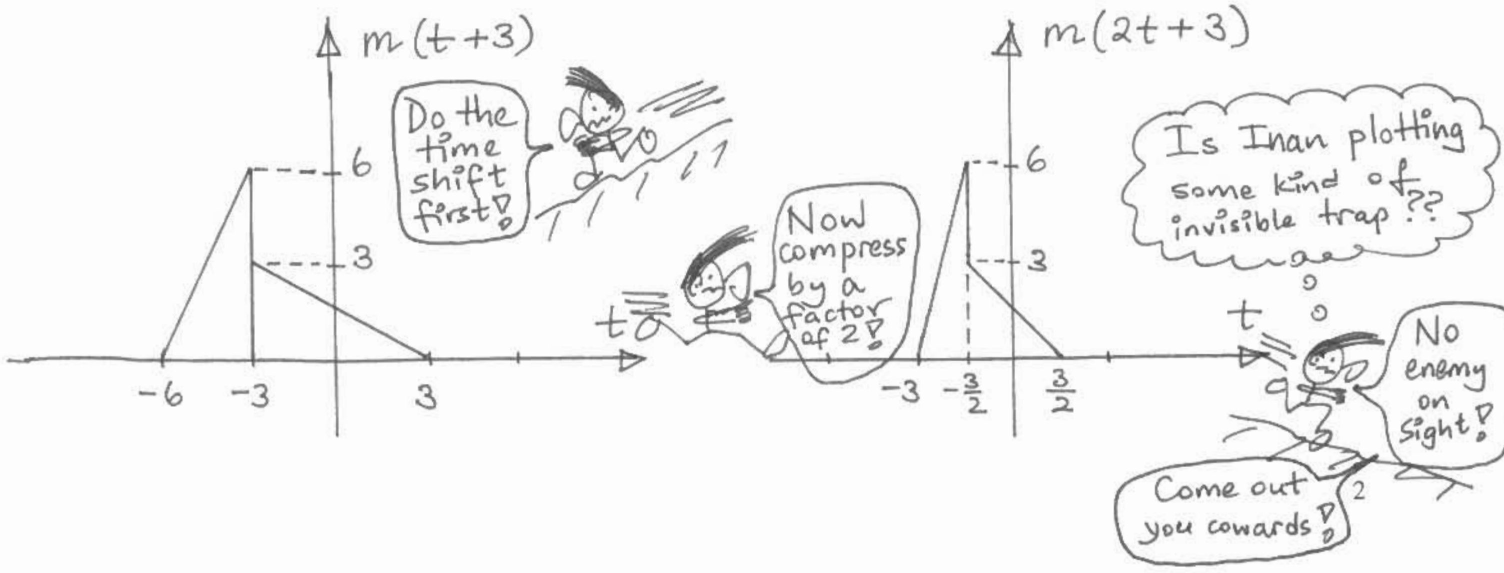
(1) (10 mins., Total: 30 points) **A continuous-time signal.** Consider the continuous-time signal denoted by $m(t)$ as shown in the figure below.



(a) (10 points) Sketch the even and odd parts of $m(t)$. Provide all the pertinent values on your sketch.



(b) (10 points) Sketch $m(2t+3)$.



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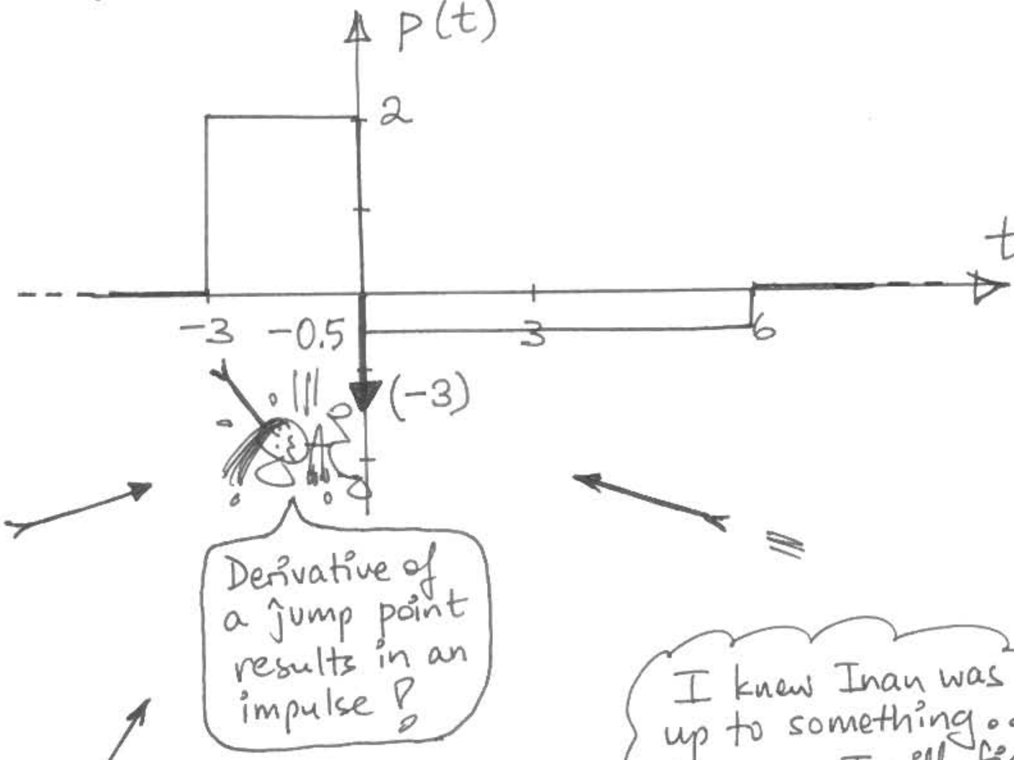
(c) (10 points) Find the function $p(t)=dm(t)/dt$ and sketch $p(t)$ versus t. Provide all the pertinent values on your sketch.

$$m(t) = 2r(t+3) - 3u(t) - \frac{5}{2}r(t) + \frac{1}{2}r(t-6)$$

d/dt

$$p(t) = \frac{dm(t)}{dt} = 2u(t+3) - 3\delta(t) - \frac{5}{2}u(t) + \frac{1}{2}u(t-6).$$



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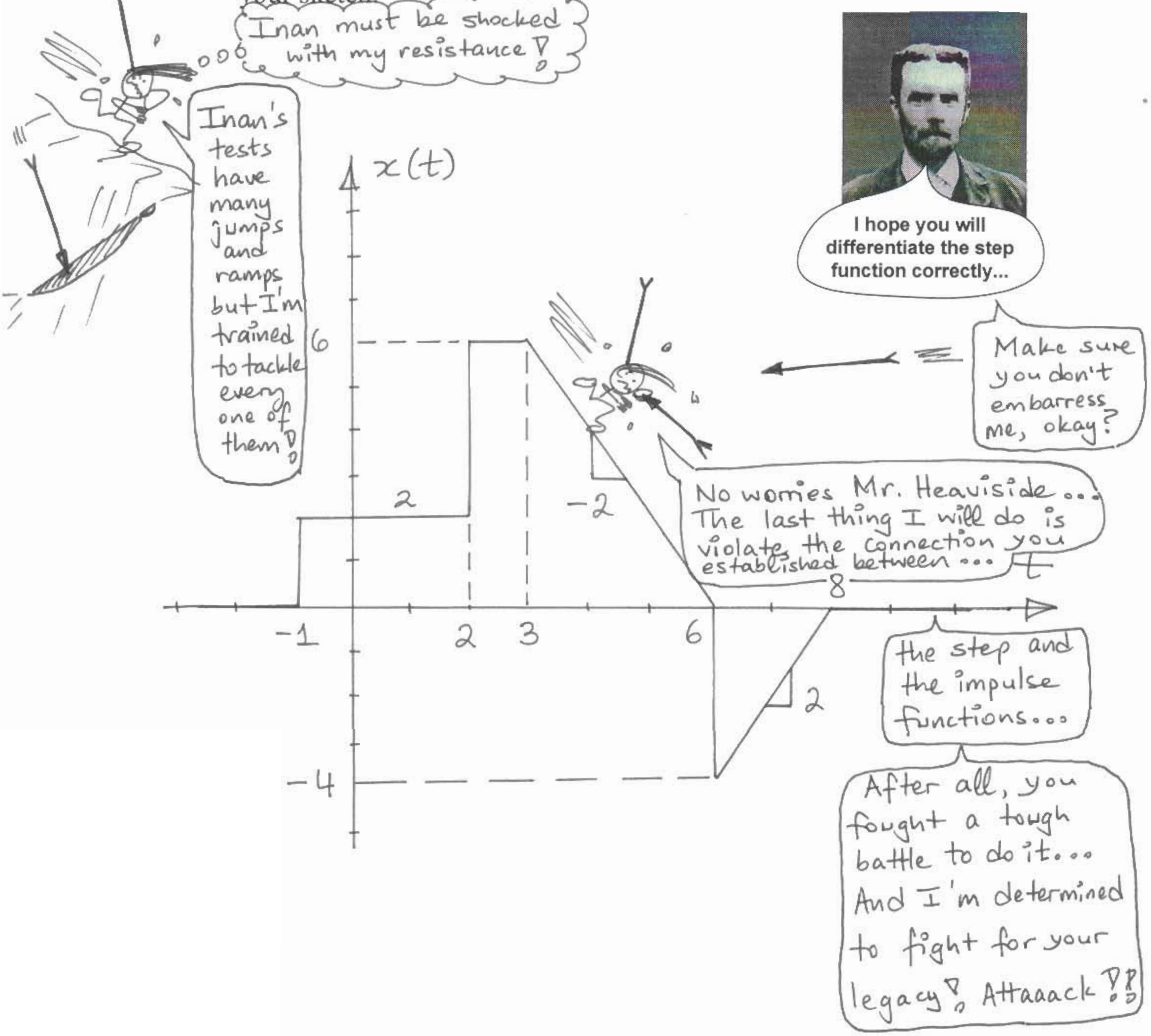
(2) (15 mins., Total: 25 points) **Impulse, step, and ramp functions.** A continuous-time signal is given by

$$x(t) = 2u(t+1) + 4u(t-2) - 2r(t-3) + 4r(t-6) - 4u(t-6) - 2r(t-8)$$

(a) (12.5 points) Sketch this signal. Provide all the necessary values on your sketch.



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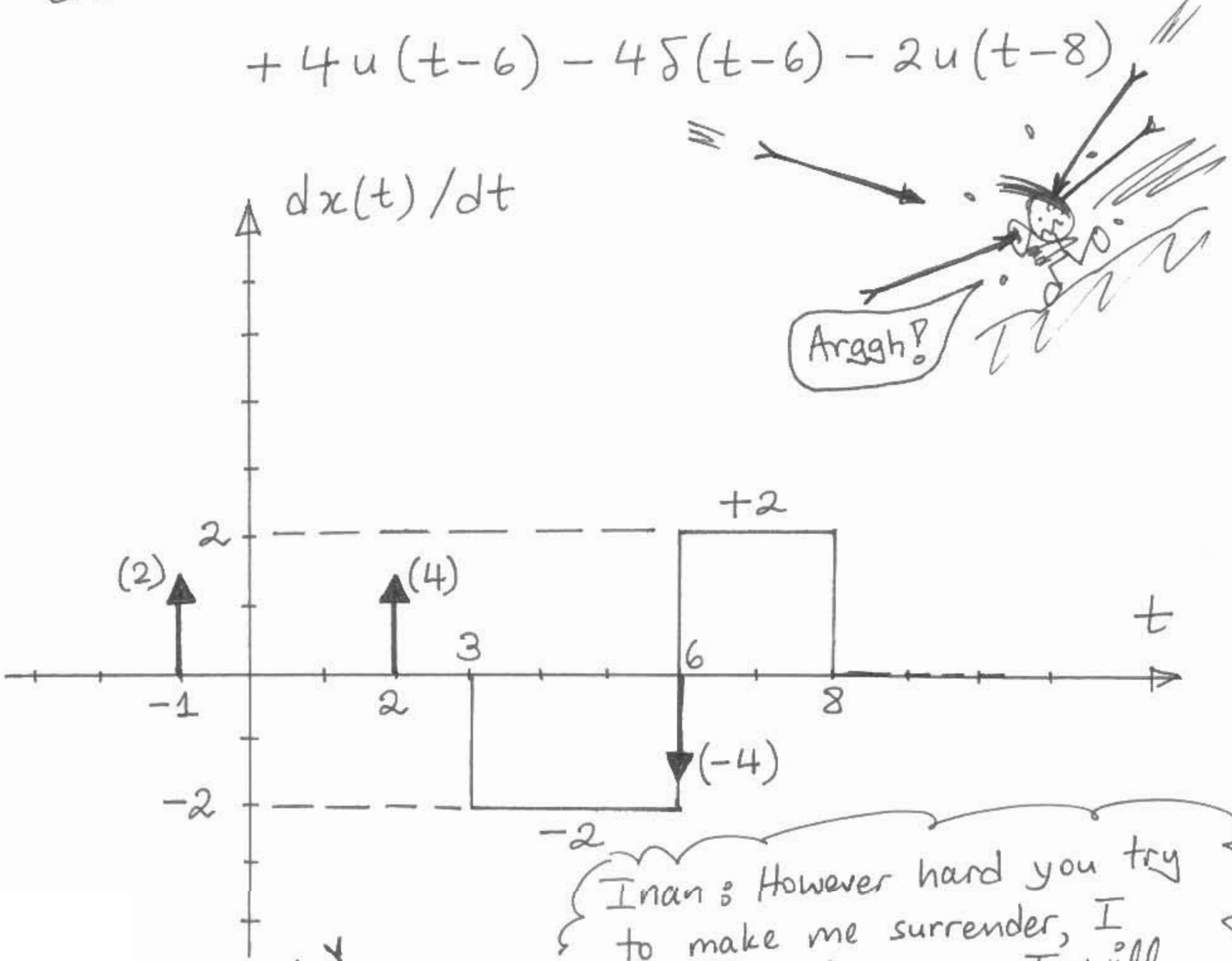
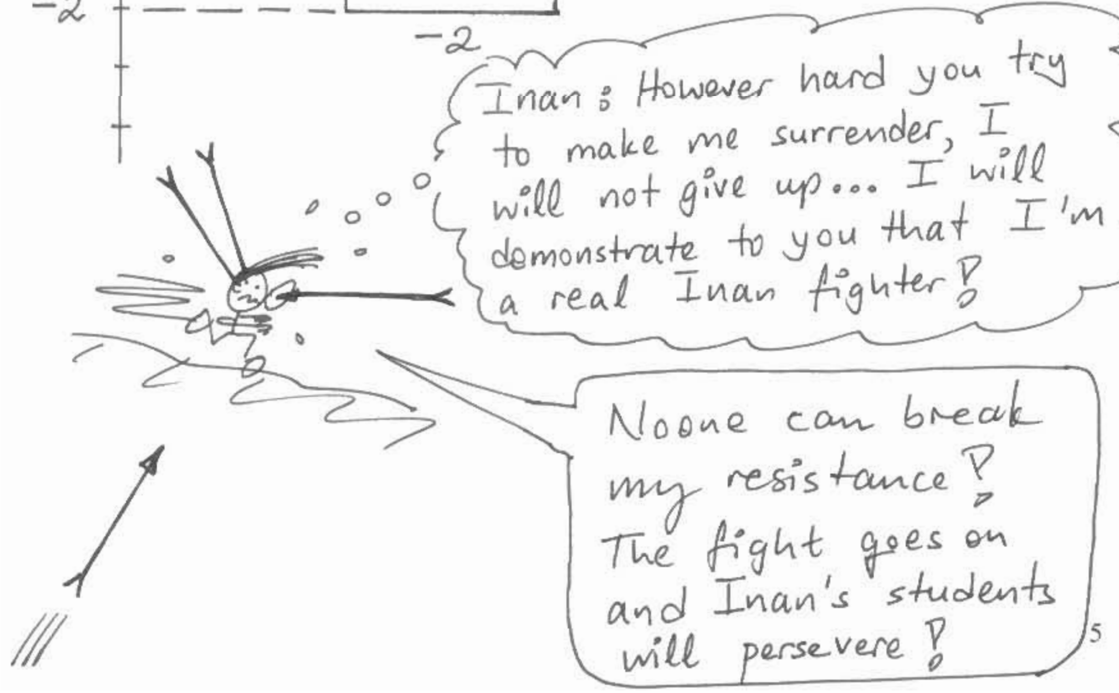
(b) (12.5 points) Using $x(t)$ given in part (a), sketch the derivative signal, dx/dt. Provide all the appropriate values on your sketch.

$$\frac{dx(t)}{dt} = 2\delta(t+1) + 4\delta(t-2) - 2u(t-3) + 4u(t-6) - 4\delta(t-6) - 2u(t-8)$$





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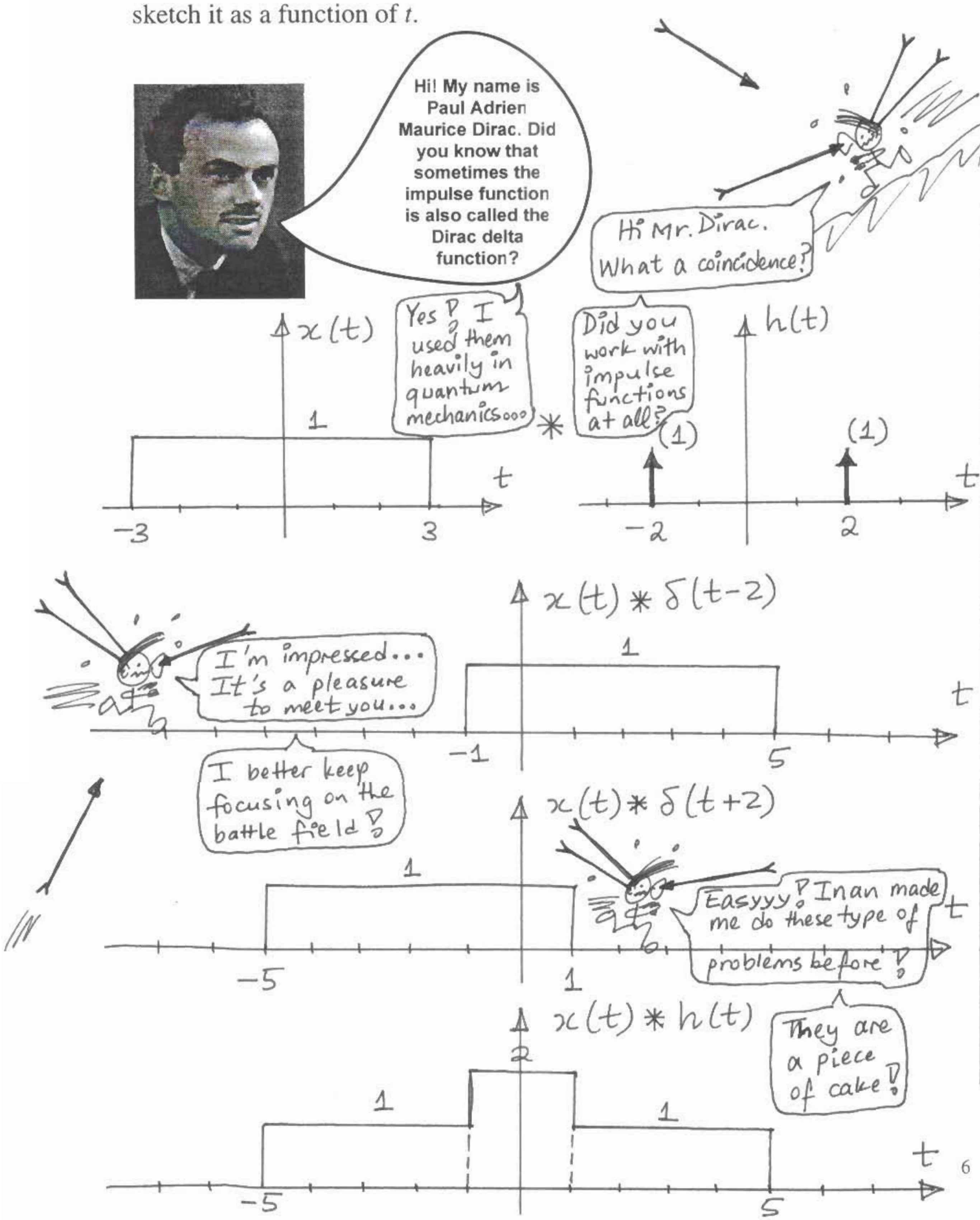
(3) (10 mins., 20 points) **Convolution integral.** Find the convolution integral $y(t) = x(t) * h(t)$ where the continuous-time signals $x(t)$ and $h(t)$ are given by $x(t) = [u(3+t) - u(t-3)]$ and $h(t) = \delta(t-2) + \delta(t+2)$ respectively. Provide the complete mathematical expression for the function $y(t)$ and sketch it as a function of t.



$$\boxed{\therefore\ y(t) = u(t+5) + u(t+1) - u(t-1) - u(t-5)}$$

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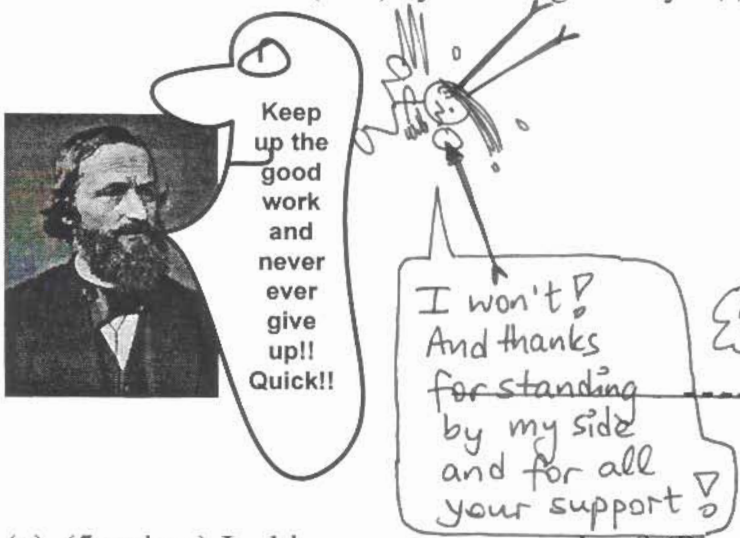
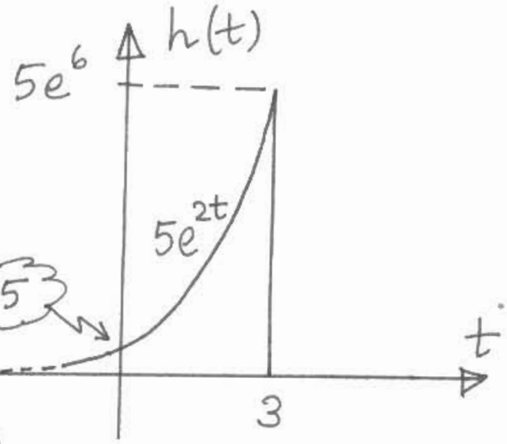
(4) (15 mins., <u>Total:</u> 25 points) **LTI system.** The impulse response of a **L**inear **T**ime-**I**nvariant (LTI) system is given by $h(t) = 5e^{2t}u(3-t)$.





(a) (5 points) Is this system memory-less? (Provide brief justification for your answer.)

<u>No</u>, since $h(t) \neq k\,\delta(t)$.

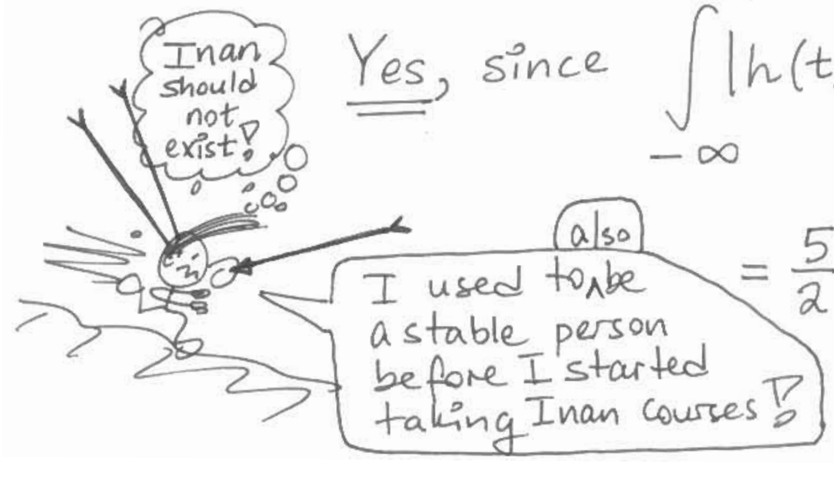
(b) (5 points) Is this system causal? (Justification.)

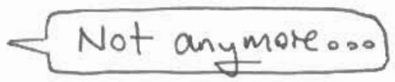
<u>No</u>, since $h(t) \neq 0$ for $t<0$.

(c) (5 points) Is this system stable? (Justification.)

<u>Yes</u>, since $\int_{-\infty}^{\infty} |h(t)|\,dt = \int_{-\infty}^{3} 5e^{2t}\,dt$

$= \frac{5}{2}e^{2t}\Big|_{-\infty}^{3} = \frac{5e^6}{2} < \infty$!





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(d) (10 points) Find and sketch the unit-step response of this system. (Don't forget to sketch it! Provide appropriate values on your sketch.)

The unit step response $g(t)$ can be found from the impulse response as

$$g(t) = \int_{-\infty}^{t} h(\tau)\, d\tau$$

$$= \begin{cases} \int_{-\infty}^{t} 5e^{2\tau} d\tau = \frac{5}{2} e^{2t} & \text{for } t < 3 \\ \int_{-\infty}^{3} 5e^{2\tau} d\tau = \frac{5e^{6}}{2} & \text{for } t > 3 \end{cases}$$

or $$\boxed{g(t) = \frac{5}{2} e^{2t} u(3-t) + \frac{5e^{6}}{2} u(t-3)}$$