Name:

Problem	Points	Score
1	10	
2	10	
3	10	
4	10	
5	10	
6	10	
7	10	
8	10	
9	10	
10	10	
TOTAL	100	

What grade do you think you deserve in this course? ______________

Explain why:

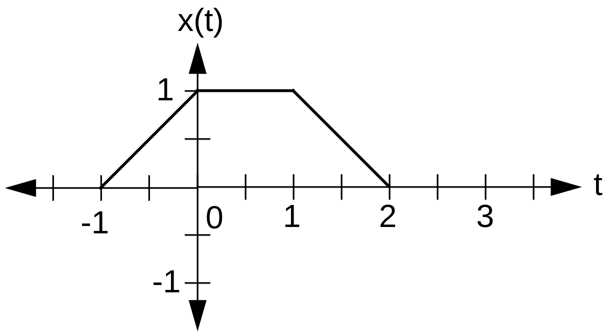
Notes:

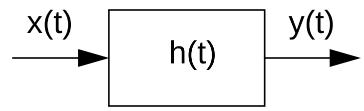
1. The exam is closed books/closed notes - except for four pages of notes.

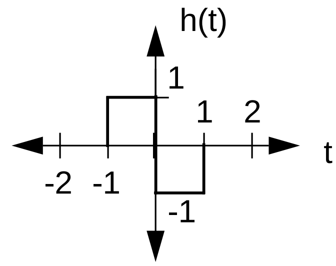
2. Please show ALL work. Incorrect answers with no supporting explanations or work will be given no partial credit.

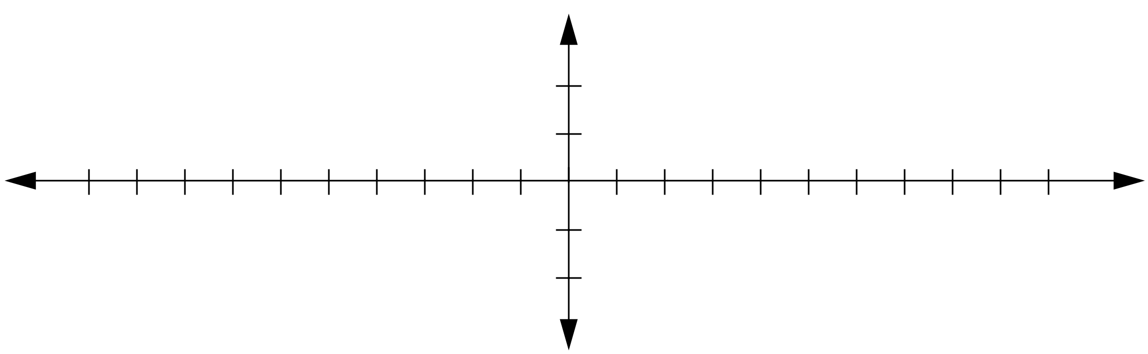
3. Please indicate clearly your answer to the problem.

Problem No. 1: For the system shown, plot $y(t)$. Explain any symmetry you observe in the output using linear system theory.







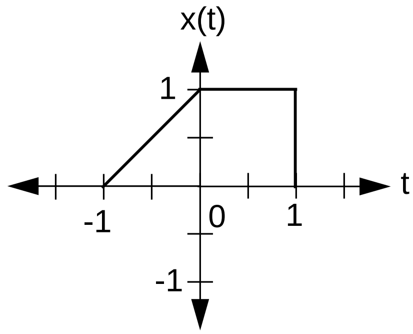


Explanation:

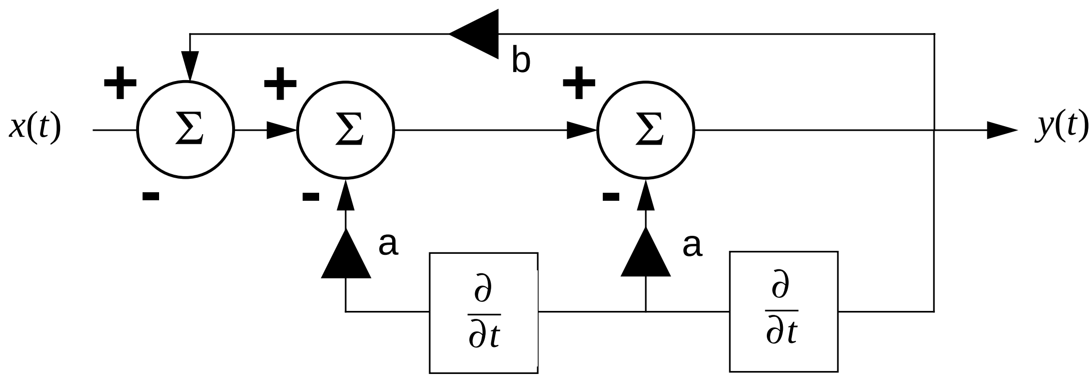
Problem No. 2: Characterize this system using as many concepts discussed in this course as possible:

$$\frac{d^2}{dt^2}y(t) + \alpha\frac{d}{dt}y(t) + \beta x(t)y(t) = 0$$

Problem No. 3: Compute the frequency response of the signal shown:

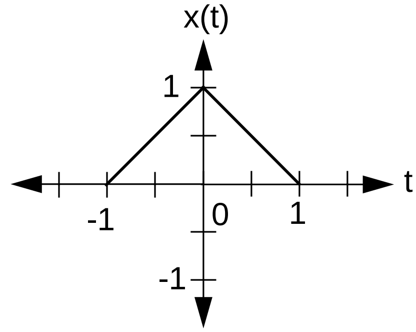


Problem No. 4: Compute the transfer function of the following system:



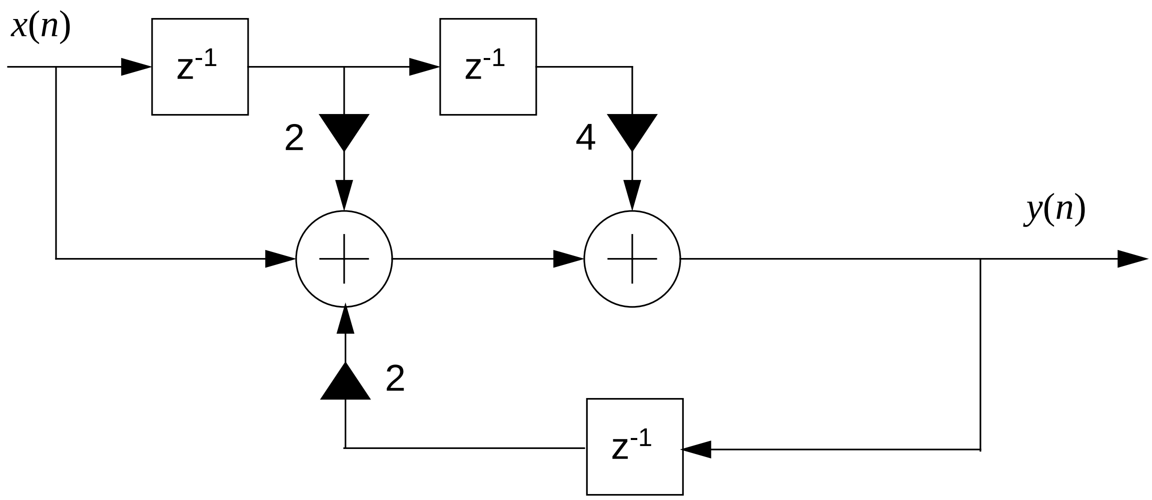
Problem No. 5: Discuss the issues involved in representing the signal shown below as a discrete-time signal.

$|Y(f)|$ $x(t)$



Problem No. 6: Prove that for discrete-time systems, delay in the time domain does not alter the magnitude spectrum of the signal. (Note that you must prove at least one theorem to do this.)

Problem No. 7: Compute the frequency response of the following discrete-time system:



Problem No. 8: Compute $y(t)$ for the following signal, $x(t)$, and system, $h(t)$:

$$x(0) = -1 \qquad h(-1) = 2$$
$$x(1) = 0 \qquad h(0) = 1$$
$$x(2) = 1 \qquad h(1) = 0$$
$$x(3) = 2 \qquad h(2) = -1$$
$$x(n) = 0 \;\; \text{elsewhere} \qquad h(n) = 0 \;\; \text{elsewhere}$$

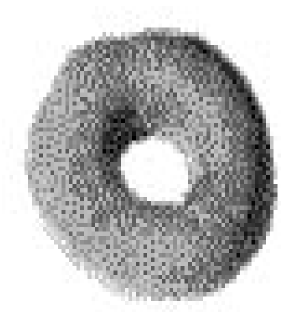
Problem No. 9: Compute the spectrum for the first signal using a 2-point DFT, compute the spectrum for the second signal using a 4-point DFT, and explain any observed similarities and differences (assume the signals start at $t = 0$):

$x_1(n) = \{1, 4\}$ $x_2(n) = \{1, 4, 0, 0\}$

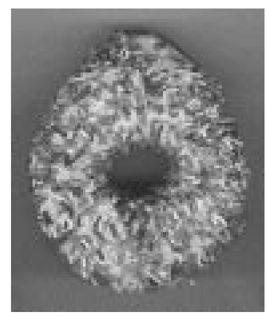
Problem No. 10: The two-dimensional DFT is defined as:

$$X(k,l) = \sum_{n=0}^{(N-1)} \sum_{m=0}^{(M-1)} x(n,m) e^{-j2\pi\frac{kn}{N}} e^{-j2\pi\frac{lm}{M}}$$

Compare the spectrum of the plain donut shown to the left to the donut with sugar sprinkles shown to the right. Note that these pictures are actually images consisting of a rectangular grid of samples (pixels), and that the degree of darkness of the images at each point is the signal amplitude. Also, note that the 2D spectrum consists of repetitions of the 1D Fourier transform spectrum taken along lines centered through the origin (refer to my comments in class). Hint: draw a straight line through the origin, plot the intensity of the image along that line, and think about what the spectrum of the signal looks like.



"plain cake donut"



donut with "sprinkles"