KECE313(02) Signals and Systems

School of Electrical Engineering, Korea University

Take-home midterm Exam (28 April 2020)

(Due 7 May 2020, 2 pm via Blackboard)

Open book and open notes. Answer all questions with detail for full credit.

For computer problems, submit your code (MATLAB, Python, etc).

1. Indicate if the following phrase is either "True" or "False". Justify your answers (10%)
   (a) The convolution integral assumes the system $h(t)$ to be linear, time-invariant(LTI) and initially at rest state condition.

   (b) In a system represented by linear constant coefficient differential equation, its impulse response $h(t)$ can be found by solving the differential equation when $x(t) = \delta(t)$ and by assuming that $h(t)$ has particular solution part $h_p(t) = \delta(t)$.

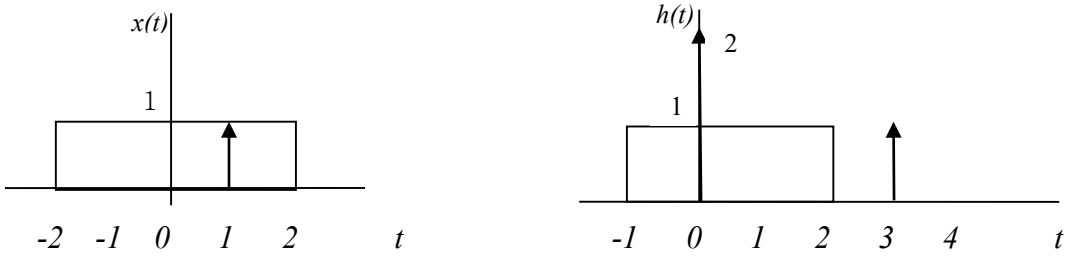
   (c) The sum of two sinusoidal signals, $x(t) = sin\frac{2\pi}{3}t + 2cos3\pi t,$ is periodic. If so, what is its period? If not, why not?

   (d) The strength of DC component of a full-wave rectifier is just $\sqrt{2}$ as that of a half-wave rectifier.

2. In the following, $x(t)$ refers to the input to a system and $y(t)$ refers to the output. Determine whether the systems are (i) linear, (ii) memoryless, (iii) time-invariant, (iv) causal. Justify your answer in each case. (15%)

   (a) $y(t) = x(t)exp(x(t))$
   (b) $y(t) = x(t-2)x(t+1)$
   (c) $\frac{dy(t)}{dt} + 2y(t) = x^2(t)$

3. Consider the sketches of input *x(t)* and impulse response function *h(t)* below. (10%)
   (a) Find and sketch the convolution $y(t)=h(t)*x(t)$ and show the intermediate steps. Express *y(t)* at each time segment.
   (b) [Computer Problem] Repeat the same (e.g. plot y(t)) by writing a computer code.

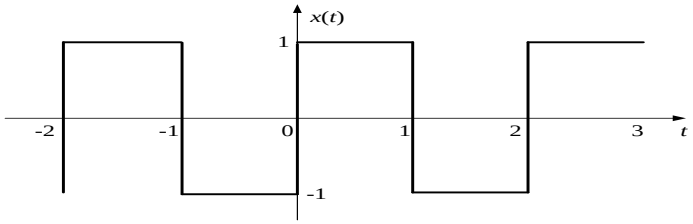


4. A first-order system is modeled by the differential equation (10%)

$$.y''(t) + 2y'(t) + 2y(t) = x'(t) + 4x(t)$$

Find the impulse response by showing the intermediate steps.

5. Consider the following periodic signal x(t). (25%)

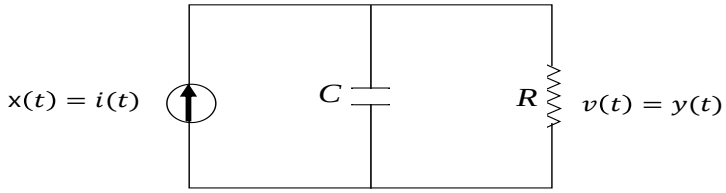


(a) Find the Fourier Series coefficient C_n of $x(t)$ and plot its magnitude and phase.

(b) **[Computer Problem]** Write a computer program to calculate the approximation $\hat{x}_N(t)$ and plot for N=1, 3, 5, 50, 1000 from t= -1 to t=2.

(c) **[Computer Problem]** Write a computer program to calculate and sketch the error function $e_N(t) = x(t) - \hat{x}_N(t)$ for N=1, 3, 5, 50 from t= -1 to t=2.

6. An initially relaxed LTI system (filter h(t)) his shown as follows. (30%)



(c) Find the defining differential equation for the filter h(t). (Assume $RC = 1$)

(d) Find the transfer function $H(\omega)$ by showing the intermediate steps.

(e) Is this HPF (high pass filter) or LPF (low pass filter). Justify your answer.

(f) Find and discuss the output if the input is: $x(t) = 4cost + cos2t$

(g) [**Computer Problem**] Write a code to calculate and sketch the output y(t) of the filter h(t) if input x(t) is the figure below (same as Problem 5)